A Quantitative Exploration of the Golden Age of European Growth: Structural Change, Public Investment, the Marshall Plan and Intra-European Trade.

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Abstract

Western European income per capita more than tripled in the two and a half decades that followed World War II. The scholarship has identified several potential factors behind this outstanding growth episode, specifically; the large migrations from agriculture to manufacture that took place in post-war Europe, the contribution of the Marshall Plan combined with the public provision of infrastructure and the surge of intra-European trade. This paper can be viewed as an attempt to formalize and quantify the direct contribution of these factors to the outstanding growth of the European Golden Age. Our conclusions highlight their limitations to fully account for that growth experience.

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1. Introduction

The group of Western European economies most directly affected by the devastation of World War II witnessed a period of outstanding growth and stability in the two decades that followed the conflict. Since then, economists have been trying to understand the sources behind this Golden Age of European growth. Our objective is to explore the quantitative plausibility of some of the hypotheses presented in this literature. On one hand this exercise strengthens our confidence in the relevance of the destruction of capital approach to account for post-war growth[1], on the other hand our analysis complements this approach by providing quantitative evidence on the relative importance of some of the additional forces behind the post-war European record.

Between 1945 and 1970 income per capita grew at an average rate of 6.69% per year in Austria, 6.62% in Germany, 5.64% in Italy, 4.61% in France, 4.12% in the Netherlands[2]. At these rates Austrian and German income per capita double every decade, Italian doubles every twelve years and French and Dutch production needs a decade and a half to double. Furthermore, this period was characterized by important increases in the capital-output ratio, a substantial redistribution of income between factors and variations in the levels of saving and investment.

The scholarship has pointed out several explanations for this outstanding episode of growth and stability. Some authors highlight the importance of the structural transformation of traditional economies, with substantial reallocations of resources from the agricultural sector to modern manufactures. Another set of scholars emphasizes the importance of the Marshall Plan and public investment as a key stimulus to growth. Finally, another stream of literature points to the relation between the Golden Age growth and the surge of intra-European trade, after a period of more than twenty years characterized by autarkic practices[3].

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[1] See Christiano (1989), Alvarez-Cuadrado (2004)

[2] The growth rates of other European countries that did not experience substantial losses of physical capital during the conflict are consistently lower, 3.1% in Norway, around 3% in Switzerland, Sweden and Denmark, and 1.95% in Britain.

[3] The literature has identified other potential factors behind the Golden Age growth. Olson (1982) argues that the conflict destroyed lobbying coalitions and delayed the development of new ones, limiting the power of interest groups and the extent of the redistributional struggle. Abramovitz (1986) emphasizes the importance of "social capability" combined with a technological gap. This last argument falls within the explanations for the European miracle that stress the importance of a steady state gap, as the reconstruction hypothesis.

In the first group, Kindleberger’s (1967), Saint-Paul (1993), Giersch, Paque and Schmieding (1993), Temple (2001) and Temin (2002) point to the substantial reallocation of resources from agricultural to nonagricultural activities that took place in post-war Europe as one of the key factors behind the exceptional growth record. The destructive impact of the war, breaking all sorts of preexisting ties, might have contributed to some degree to these intense migrations.

During the cold war years some scholars sought to demonstrate a cause-effect relation between the Marshall Plan and the remarkable economic performance in post-war Europe. Mayne (1973), Gimbel (1976) and Mee (1984) argue that the Marshall Aid provided enough funds to finance public expenditure, to eliminate bottlenecks that obstructed economic growth and to guarantee the needed flow of imports. The combination of the Plan with the observed expansion in the provision of public capital during the early fifties might account for some important features of the post-war performance.

Finally, Jensen (1967), Llewellyn and Potter (1982), Hennings (1982), Van Rijckeghem (1982), Milward (1984), Giersch et al. (1993) emphasize the relation between technological innovations, intra-European trade and export-led growth as a key determinant of this successful episode.

In this paper we make use of fully specified models to quantify the plausibility of the aforementioned hypotheses. We evaluate them along several dimensions, comparing their implications with the stylized facts of post-war Europe identified by Alvarez-Cuadrado (2004). Our results suggest that the direct effects of labor reallocation, the Marshall Plan and the process of European integration, although significant, cannot account for most of the growth of the European Golden Age.

The paper is organized as follows. Section 2 documents the stylized facts of the Golden Age of European growth. Section 3 quantifies the contribution of structural change as a key source of output growth. Section 4 analyzes the potential effects of the Marshall Plan and infrastructure investment. Section 5 focuses in the role played by international trade and the conclusions are summarized in Section 7.

2. The stylized facts of the Golden Age of European growth.

In the two decades following World War II western European economies experienced a unique episode of uninterrupted growth and stability. Between 1950 and 1970 income per capita almost tripled in Germany, Austria and Italy and more than doubled in France and the Netherlands. The high rate of growth of income was accompanied by important increases in capital intensity, substantial changes in the distribution of income between factors, and variations in the saving and investment rates.

Table 1 and Figure 1 illustrate the evolution of the growth rate, capital-output ratio, saving rate and labor income share during the European Golden Age for a group of economies directly affected by the war (Austria, Germany, Italy, France and the Netherlands). In order to better illustrate the common patterns of the European economies we reproduce the evolution of those same variables for other OECD economies which arguably are moving along their stable growth path. We recognize the following stylized facts characterizing the post-war Western European experience:

- **Stylized fact 1.** The Golden Age is characterized by high and slowly decreasing growth rates.
- **Stylized fact 2.** Between 1955 and 1970 the capital-output ratio smoothly increases[4].
- **Stylized fact 3.** The saving rate exhibits a characteristic inverted u-shape. During the first years monotonically increases reaching its maximum after more than a decade, thereafter slowly decreases.
- **Stylized fact 4.** The wage share exhibits an upward trend, increasing on average above 12% in the period considered.

A priori these facts are broadly consistent with some of the arguments suggested in the literature. If the productivity of labor and capital intensity is higher in manufacture than agriculture, large migrations from rural to industrial areas might lead to substantial increases in output, capital-output ratio and wage share. Increases in public infrastructure can lead to a period of private investment and growth. Finally, growing volume of international trade allows an economy to shift resources into more productive uses, fosters competence limiting the power of domestic monopolies, increases the size of the market enabling important economies of scale to be realized and accelerates the process of technological diffusion, all these factors might be translated into substantial increases in income per capita.

3. Large migrations from agriculture to the manufacturing sector.

[4] Alvarez-Cuadrado (2004) provides alternative rationalizations for the initial dip in the capital-income ratio.

Several authors point to the substantial reallocation of resources from agricultural to nonagricultural activities that took place in post-war Europe as one of the key factors behind the outstanding growth record of this period. The destructive impact of the war, breaking all sorts of preexisting ties, might have contributed to some degree to this intense reallocation of the labor force.

Along these lines, Saint-Paul (1993) points to these massive migrations as one of the key determinants of the performance of total factor productivity in post-war France. Furthermore he claims that, as opposed to Great Britain, there is a sense in which France joined the industrial revolution only after the end of the conflict. Giersch, Paque and Schmieding (1993) highlight the importance of internal migrations, mainly among refugees and expellees from the East who were initially allocated in rural areas, for the German growth record. Kindleberger's (1967) thesis is that the major factor shaping the remarkable economic growth of post-war Europe has been the availability of a large supply of labor. Temin (2002) argues that high growth of the European Golden Age reflects the end of the misallocation of resources generated by the interwar autarkic model. At the end of the war, Continental Europe had too much labor in agriculture for its level of income and stage of development. As a result, the post-war period was characterized by large migrations, important gains in efficiency and outstanding growth. Finally, Temple (2001) extends the standard growth accounting framework to measure the contribution of labor reallocations to total factor productivity growth. He reports estimates of the lower bound of the (direct) contribution of labor reallocation to aggregate total factor productivity growth close to one percentage point for this decade.

As an example, in Italy the share of population devoted to agriculture decreased from 40% in 1950 to 18% in 1970. Figure 2 summarizes the evolution of the share of the labor force devoted to agriculture for our sample economies and the control group. In post-war Europe almost 17% of the population migrated from the countryside to urban areas, while this figure is below 8% in our control group.

Assuming that the productivity of labor and capital intensity are higher in manufactures than in agriculture[5], large migrations from rural to industrial areas might lead to substantial increases in output, capital-output ratio and wage share, consistent with the stylized facts of the post-war period. Particularly we are interested in whether this migration process is able to account for the substantial increase in the income share

[5] Gollin, Parente and Rogerson (2002) report that output per worker in non-agriculture is substantially higher than in agriculture.

of labor (stylized fact 4), without the need to make further assumptions about the production technology. In order to explore this hypothesis, we borrow the model from Gollin, Parente and Rogerson (2002).

3.1 A model of structural change.

They extend a one-sector neoclassical growth model to include an explicit agricultural sector. Their economy is populated by an infinitely-lived representative agent, that derives satisfaction from the consumption of a non-agricultural good $\left(C_t\right)$ and a non-storable agricultural good $\left(A_t\right)$ according to the following Stone-Geary specification:

$$U\left(C_t, A_t\right) = \frac{C_t^{1-\sigma}}{1-\sigma} + \bar{A} \qquad \text{if } A_t \geq \bar{A}$$
$$= A_t \qquad \text{if } A_t < \bar{A} \tag{3.1}$$

where $\sigma > 0$ is a measure of the willingness of the representative agent to shift consumption over time.

Agricultural output $\left(Y_{at}\right)$ is produced using labor $\left(N_{at}\right)$ and land $\left(T\right)$ that for simplicity remains fixed in supply. The efficiency of labor in this sector $\left(E_{at}\right)$ grows exponentially at the exogenous rate γ_a. These factors are combined according to the following Cobb-Douglas technology:

$$Y_{at} = B_a \left(T\right)^{\alpha} \left(E_{at} N_{at}\right)^{1-\alpha} \tag{3.2}$$

Output from the agricultural sector can only be consumed, so the agriculture resource constraint is simply $Y_{at} \leq \bar{A}$. In the early stages of development all the labor force is employed in agriculture, as output per capita in the agricultural sector reaches $\bar{A}$, labor will migrate to the manufacturing sector. Our preferences capture the idea that once a society reaches a certain level of nutrition there is little room for expanding agricultural production beyond the increases necessary to provide for the additional population.

In the limit agriculture's employment share shrinks to zero and the model converges to the one-sector neoclassical model.

The manufacturing sector produces output $\left(Y_{mt}\right)$ combining capital $\left(K_t\right)$ and labor $\left(N_{mt}\right)$ according to the neoclassical technology:

$$Y_{mt} = B_m \left(K_t\right)^{\mu} \left(E_{mt} N_{mt}\right)^{1-\mu} \tag{3.3}$$

Technological change in the manufacturing sector increases the efficiency of labor $\left(E_{mt}\right)$ at the exogenous rate γ_m.

Output from the manufacturing sector can be used for consumption or investment, and therefore the law of motion for the stock of capital, that depreciates a constant rate δ, is

$$\dot{K}_t = Y_{mt} - C_t - \delta K_t \tag{3.4}$$

Finally, the representative agent inelastically supplies a unit of labor $\left(N\right)$ that can be allocated into two alternative uses, agriculture $\left(N_{at}\right)$ and manufactures $\left(N_{mt}\right)$.

3.2 Macroeconomic equilibrium.

Solving for the competitive equilibrium involves two steps. The first step determines the evolution of the labor allocation across sectors. Preferences imply that labor will be allocated entirely to the agricultural sector until $Y_{at} = \bar{A}$. Once this critical level is reached, the labor force will migrate to the manufacture sector at the rate of technological change in agriculture[6]. Therefore the proportion of labor force employed in manufactures grows at the rate,

$$\hat{N}_{mt} \equiv \frac{\dot{N}_{mt}}{N_{mt}} = \frac{\gamma_a N_{at}}{1 - N_{at}} \tag{3.5}$$

Having the time path for labor allocations, the second step solves for the optimal consumption rule. The optimality conditions for this problem, where β is the rate of time preference and λ is the co-state variable associated to the capital stock, are

$$C_t^{-\sigma} = \lambda_t \tag{3.6a}$$

$$\mu \frac{Y_{mt}}{K_t} - \delta = \beta - \frac{\dot{\lambda}_t}{\lambda_t} \tag{3.6b}$$

together with the transversality condition

$$\lim_{t \to \infty} \lambda_t K_t e^{-\beta t} = 0 \tag{3.6c}$$

[6] Given that we are focusing on economies where the initial level of manufacturing output is non-trivial, the problems of (3.1) for small levels of consumption and of (3.3) for initial level of capital are ignored, without affecting the relevance of our results. Furthermore, we assume a constant level of population, although our results are still valid under a constant rate of population growth.

The interpretations of (3.6a) and (3.6b) are standard; (3.6a) equates the marginal utility of consumption to the shadow value of capital, while (3.6b) is an intertemporal allocation condition equating the marginal product of capital to the rate of return on consumption.

In line with the literature, we define a balanced growth path as being one along which all variables grow at a constant rate. With capital being accumulated from final output, the only balanced solution is one in which the capital-output ratio, K/Y, remains constant. Following this definition it is convenient to write the system in terms of the following stationary variables, $k \equiv \frac{K}{E_m N_m}$ $c \equiv \frac{C}{E_m N_m}$. Combining these variables with (3.3), (3.4),(3.5) and (3.6), the dynamic behavior of the economy can be described by a system of differential equations in k, N_a and c, where for simplicity we suppress the time subscripts,

$$\dot{k} = B_m k^{\mu} - c - \left(\gamma_m + \delta + \frac{\gamma_a N_a}{1 - N_a} \right) k \tag{3.7a}$$

$$\dot{c} = \frac{c}{\sigma} \left\{ \mu B_m k^{\mu - 1} - \delta - \beta - \left(\gamma_m + \frac{\gamma_a N_a}{1 - N_a} \right) \sigma \right\} \tag{3.7b}$$

$$\dot{N}_a = -\gamma_a N_a \tag{3.7c}$$

Imposing the steady state condition, $\dot{c} = \dot{k} = \dot{N}_a = 0$, we can solve (3.7) for the steady-state values of the scale-adjusted variables, k^* and c^*, and the equilibrium labor allocation, N_a^*, as follows

$$k^* = \left[\frac{\beta + \delta + \gamma_m \sigma}{B_m \mu} \right]^{\frac{1}{\mu - 1}} \tag{3.8a}$$

$$c^* = B_m \left(k^* \right)^{\mu} - \left(\delta - \gamma_m \right) k^* \tag{3.8b}$$

$$N_a^* = 0 \tag{3.8c}$$

Since we are interested in evaluating the dynamic behavior of an economy starting at a point that lies far away from steady state, the conventional reliance on linear approximations might lead to substantial errors[7]. Under these circumstances we decided to solve numerically the non-linear system of differential equations that governs the dynamics of our economy.

3.3 Numerical Analysis.

Following Judd's (1992) collocation method, we use an eight degree Chebyschev polynomial basis to approximate the solution of (3.7). Denoting these approximate solutions for consumption, capital and labor share in agriculture as $\hat{c}, \hat{k}$ and $\hat{N}_a$, respectively, we define our residual functions as the difference between the left hand side and the right hand side of (3.7). Twenty seven residual conditions are derived for nine time nodes and three additional conditions are determined by (3.6c), the initial capital stock and the initial share of labor in agriculture. As a result we end up with a system of 30 linear equations on the 30 unknown coefficients of the approximate time paths. We solve this system using Broyden's method. Finally we evaluate our solution over a set of 10,000 points over an interval of 200 periods, the maximum consumption residual is 0.0003 that in relative terms implies an error of 2 cents out of every $100 worth of consumption.

We calibrate our model to reproduce some of the key features of the post-war western European economies economies. Table 2 summarizes the parameters upon which our simulations are based and the steady state values of some relevant economic variables. Since our production technologies do not exhibit scale effect we normalize $B_a = B_m = 1$. The intertemporal elasticity of substitution, $1/\sigma = 0.4$, and the rate of time preference are chosen so that the steady state interest rate is 7% and the equilibrium savings rate is around 24%. We set the rate of technological change in the manufacturing sector, $\gamma_m = 0.02$, to be consistent with the average growth rate of our sample economies over the last century[8]. The constant rate of depreciation is assumed to be 5%. The parameter γ_a is set so that the model tracks the evolution of the sectoral allocation of

[7] We still use a linear approximation of (3.7) around (3.8) to calculate the asymptotic speed of convergence represented by the larger negative eigenvalue. This information is used to transform the infinite horizon problem into an equivalent finite horizon one.
[8] Maddison (2001) reports the following average growth rates of per capita real output for the twentieth century; Austria, 1.96%, France, 2.02%, Germany, 1.87%, Italy 2.32% and Netherlands, 1.84%.

labor between 1950 and 1970[9]. We choose a value of $\bar{A}$ so that the model matches the share of agricultural production in total output during the 50's. In the manufacturing sector the capital share parameter, μ, is set to 0.4 in line with the calculations of Cooley and Prescott (1995). The empirical evidence on agricultural labor income shares is difficult to interpret as a measure to calibrate the elasticity of agricultural production to labor given the high degree of under-employment (family workers, illegal immigration) that characterizes this sector. Our base calibration is based in Schulz (1951) calculations of the relative amounts of inputs employed for agricultural production, which leads to a value of the labor income share in the agricultural sector, $(1-\alpha)$ equal to 0.45. Solow (1958) reports the share of compensation of employees in income originated in agriculture to be of the order of 15%-20%. Da-Rocha and Restuccia (2003) choose a labor income share of 10% using an average of employment compensation relative to GDP adjusted for proprietor's income in the farm sector from the U.S. Bureau of Economic Analysis. As a result of these difficulties, we will conduct our simulations under alternative values for this parameter, which is crucial for the evolution of the factor shares.

Figure 3 compares the transitional dynamics of our calibrated economy with those in the actual data. The rapid growth of agricultural productivity leads, not only to a massive reallocation of resources from agriculture to manufactures, but also to an important increase in aggregate output. As in post-war Europe this type of structural change is characterized by high and slowly declining growth rates, nonetheless the model predictions substantially understate the growth performance during the Golden Age. This growth differential translates into an increasing gap between the share of agriculture in GDP predicted by the model and the one observed in the data, even under the assumption that consumption of the agricultural commodity is subject to satiation. In our model economy, the only storable commodity is manufacturing output therefore the progressive migration of labor between sectors leads to a transition characterized by a monotonically increasing saving rate, in line with the increases observed in postwar Europe. This increase in investment combined with the diminishing returns to capital exhibited by our

[9] Jorgeson and Gollop (1992) estimate that productivity growth has been high in agriculture relative to service and manufacture sectors for East Asian countries. In the European context, Postman (1967) reports 10-year increases in agricultural productivity for Germany (76%), Denmark (45%) and the Netherlands (20%). Our calibrations of the rate of technological change in the traditional sector are consistent with this evidence.

Cobb-Douglas technology lead to a smoothly increasing capital-output ratio qualitatively similar to the path observed in the data. Finally, our calibrated model, although qualitatively predicts the evolution of the labor share in income, is not able to capture the extent of this process. In order to maximize the explanatory power of our model on this issue, we reduce the labor share parameter in the agriculture production function down to .05, well below any relevant empirical evidence. Even under this extreme assumption, our model is only able to generate a 8% increase in the wage share, well below the 12% increase observed over the 20 years period. As a result, we conclude that post-war evolution of the labor share cannot be fully explained in terms of the reallocation of labor from a traditional agricultural sector to manufactures, and therefore we might need to abandon the familiar Cobb-Douglas world, with its unitary elasticity of substitution between factors, in favor of a more flexible production structure to be able to account for this pattern.

4. The Marshall Plan and the role of government productive expenditure.

The Marshall Plan transferred $13 billion in aid from the United States to Western Europe between 1948 and 1951. In terms of the donor's national income the transfers represented 2.1% of GNP in 1948, rising to 2.4% in 1949 and then falling down to 1.5% the remaining two years. In absolute terms, over the four-year period of the plan, $2.7 billion went to France, $1.5 billion to Italy, and $1.43 billion to Germany. Aid was not allocated in any fixed proportion to national income but on average the per year transfers amounted 2.5% of GDP for France, 2.2% for Italy, 1.1% for Germany, close to 4% for the Netherlands and even a higher percentage for Austria, according to the calculations of the Bank of International Settlements reported by Milward (1984).

During the cold war years American scholars sought to demonstrate a cause-effect relation between the Marshall Plan and the remarkable economic performance in post-war Europe. In De Long and Eichengreen (1991) terminology, the "folk wisdom" of international relations argues that the Marshall Aid provided enough funds to finance public expenditure, to eliminate bottlenecks that obstructed economic growth, to guarantee the much needed flow of imports and for private investment in a period of relatively low domestic saving rates. Mayne (1973), Gimbel (1976) and Mee (1984) support this vision of post-war Europe.

Milward (1984) downplays substantially the importance of the Plan. He argues that the post-war European growth record would not have been very different in its absence. Nonetheless, he admits that the Plan helped governments to widen bottlenecks in the recovery process, where this was dependent on public investment.

Maier (1987) and De Long and Eichengreen (1991) prefer an interpretation that stresses the importance of the Plan to guarantee the continuity of market or quasi-market institutions providing room for a new growth oriented social contract.

As a first step to assess the economic impact of the Plan it is important to understand the allocation of the aid. Around 32% of the aid was devoted to food imports, almost 15% to cotton imports, 4.4% to tobacco, 15.5% to fuel with the remaining 33% evenly distributed between raw materials and capital goods. De Long and Summers (1992) highlight the connection between equipment investment and growth, along this line, imports of capital goods amounted 23.4% of the total aid in France, 20.6% in Italy, 3.3% in Germany, 24.2% in the Netherlands and 11.3% in Austria. These imports were mainly directed towards infrastructure development, such as electricity, gas, power supply, transport and communications. These are the "commanding heights" of the economy, i.e. those sectors which needed to expand before the rest of the economy could.

Barro (1990) recognizes the important interactions between productive government spending and growth. Furthermore, the introduction of public capital as an input in the aggregate production function leads to an important role for public investment in the growth process. Along these lines, Saint-Paul (1993) highlights the positive role played by the French government providing the economy with modern infrastructure after the war. In the case of Italy, Postan (1967) points out that government sponsored agencies pioneered important industrial projects and build up the Italian road system. In the next section, we present a model that allows us to quantify the joint effects of productive government expenditure and foreign aid in the post-war period.

4.1 A model with productive public capital and foreign aid.

4.1a The Private Sector

We consider an economy populated by single representative household whose welfare is represented by the intertemporal sum of the isoelastic utility function:

$$\Omega \equiv \int_0^\infty \frac{1}{1-\sigma} C^{1-\sigma} e^{-\beta t} dt \qquad (4.1)$$

where C denotes consumption, $1/\sigma$ is the elasticity of substitution between consumption at two points in time and β is the rate of time preference. The representative firm produces output, Y, combining private capital, K, and public capital or infrastructures, K_G, according to the following Cobb-Douglas technology:

$$Y = \alpha \left[\frac{K_G}{K} \right]^{\eta} K = \alpha K_G^{\eta} K^{1-\eta} \qquad (4.2)$$

The firm faces decreasing returns to scale in the private factor, and constant returns to scale in both factors, as in Futagami, Morita and Shibata (1993). The model abstracts from labor, so that private capital should be interpreted broadly to include human, technological, as well as physical, capital as argued by Barro and Sala-i-Martin (1995). Private capital, that depreciates at a rate, δ_K, is accumulated out of income net of taxes, τ, after allowing for consumption net of lump sum foreign transfers, $\overline{T}$. Therefore the law of motion of the private capital stock is,

$$\dot{K} = (1-\tau)Y - C - \delta_K K + \overline{T} \qquad (4.3)$$

Thus we assume that the representative agent maximizes his utility function, (4.1), subject to the budget constraint, (4.3), and treating the stock of public capital, K_G, as given and independent of his own decisions. The optimality conditions for this problem, where λ is the co-state variable associated with the capital stock are[10],

$$C^{-\sigma} = \lambda \qquad (4.7a)$$

$$(1-\tau)(1-\eta)\frac{Y}{K} - \delta_K = \beta - \frac{\dot{\lambda}}{\lambda} \qquad (4.7b)$$

together with the transversality condition,

$$\lim_{t \to \infty} \lambda K e^{-\beta t} = 0 \qquad (4.7c)$$

The interpretation of (4.7) is standard. (4.7a) equates the marginal utility of consumption to the shadow value of capital and (4.7b) is an intertemporal allocation conditions equating the net marginal physical product of private capital to the rate of return on consumption.

Log differentiating (4.7a) and combining the result with (4.7b), we reach the following law of motion for the growth rate of consumption,

[10] Throughout the analysis, time subscripts are omitted when uncontroversial.

$$\frac{\dot{C}}{C} = \frac{1}{\sigma}\left[(1-\tau)(1-\eta)\frac{Y}{K} - \delta_K - \beta\right] \quad (4.8)$$

4.1b Public Sector and the Marshall Plan

In order to replicate the effects of the American aid after World War II, we allow our economy to receive a temporary transfer. We model this transfer as a constant fraction of output, mY. Furthermore we allow for a percentage of the transfer, ξ, to be tied to the provision of public infrastructures. Aside from foreign aid, we assume the economy is closed and therefore the domestic stocks of private and public capital uniquely determine the equilibrium interest rate[11]. The model could be easily extended to an open economy set up, but for the purpose of our analysis this distinction is irrelevant.

The government in our economy obtains resources for the provision of public infrastructures from two sources: domestically financed government expenditure, $\overline{G}$, and the tied proportion of the Marshall aid, ξmY. In order for an equilibrium growth path to be sustained, the current flow of government expenditure in infrastructure must be tied to the size of the economy. As a result, we model it as a constant fraction of output, $\overline{g}$, therefore,

$$\overline{G} = \overline{g}Y \quad (4.9a)$$

$$G = \overline{G} + \xi mY = (\overline{g} + \xi m_t)Y = g_t Y \quad (4.9b)$$

We assume that new output and the tied fraction of foreign aid can be transformed costlessly to new public capital. Therefore government capital, that depreciates at the rate, δ_G, accumulates in accordance with,

$$\dot{K}_G = G - \delta_G K_G = g_t Y - \delta_G K_G \quad (4.10)$$

Finally, we assume that the government balances the budget every period through a proportional tax on income, $\tau = \overline{g}$. The untied proportion of the Marshall aid, $(1-\xi)m_t$, enters the resource constraint as a pure transfer, of the Keynes-Ohlin type. As a result,

[11] Under the strict capital controls of the early Bretton Woods agreement the closed economy assumption seems a sensible one. The Articles of Agreement of the IMF limited convertibility to current account transactions with the intention to reduce the instability created during the interwar period by private capital flows. In this line, Saint-Paul (1993) characterizes the French economy as "exchange controls prevailed, imports were severely restricted, the market for foreign exchange was severely regulated and segmented with a complicated system of multiple exchange rates." In this context, the close economy assumption under which the return to capital is the equilibrium price of the domestic market for loanable funds seems more realistic than an open economy assumption under which the return to capital is pinned down by the prevailing world interest rate.

combining (4.3) with the balanced budget condition and our description of the Marshall aid we reach the following aggregate resource constraint,

$$\dot{K} = Y + mY - C - \delta_K K - g_t Y = \left(1 - \overline{g} + \left(1 - \xi\right) m_t\right) Y - C - \delta_K K \tag{4.11}$$

4.2 Macroeconomic equilibrium.

We define a stable growth path as one along which, aggregate output, private and public capital, and consumption are growing at the same constant rate, so that the output-capital ratio and the ratio of public to private capital remain constant. Since our objective is to analyze the behavior of the economy about this long-run equilibrium it is convenient to define the following variables, $z = K_G / K$ and $c = C/K$, that remain stationary along such a path. Rewriting our system in terms of these stationary variables we get the following set of dynamic equations,

$$\frac{\dot{z}}{z} = g_t \alpha z^{\eta-1} - \delta_G - \left(1 - \overline{g} + \left(1 - \xi\right) m_t\right) \alpha z^{\eta} + c - \delta_K \tag{4.12a}$$

$$\frac{\dot{c}}{c} = \frac{1}{\sigma}\left(\left(1 - \overline{g}\right)\left(1 - \eta\right) \alpha z^{\eta} - \delta_K - \beta\right) - \left(1 - \overline{g} + \left(1 - \xi\right) m_t\right) \alpha z^{\eta} + \delta_K + c \tag{4.12b}$$

Imposing the equilibrium condition, $\dot{z} = \dot{c} = 0$, (4.12a) and (4.12b) determine a pair of nonlinear equations in z^* and c^* that may or may not be consistent with a proper steady state where $z^* > 0$ and $c^* > 0$, Futagami et al. (1993) and Turnovsky (2000) provide sufficient conditions for this equilibrium to be well-defined and evaluate the dynamic properties of associated linear system. The common steady state growth rate of consumption, output and the two capital stocks may be expressed in the following form,

$$\hat{C}^* = \hat{K}^* = \hat{K}_G{}^* = \hat{Y}^* = \left(\overline{g} + \xi m_t\right) \alpha \left(z^*\right)^{\eta-1} - \delta_G = \frac{1}{\sigma}\left[\left(1 - \overline{g}\right)\left(1 - \eta\right)\left(z^*\right)^{\eta} - \delta_K - \beta\right] \tag{4.13}$$

Since the steady state gap generated by a temporary increase of government expenditure of the order of the Marshall Aid is relatively small, we will work with a linearized version of (4.12).

4.3 Numerical Analysis.

We calibrate our model to reproduce some of the key features of the post-war period. The proportion of government investment in income is set equal to .15 the average value of non-military government expenditure in our sample of economies during the two decades that followed the war. The elasticity of output to public infrastructures is set to 0.2, within the range of consensus estimates[12]. The rates of depreciation of private and public capital are set equal to 0.05, a non-controversial value. The scale parameter in the production function is set to produce a steady state growth rate of 2 %. The preference parameters are set equal to the ones in the previous section leading to a rate of consumption out of disposable income slightly above 60 % and a ratio of public to private capital close to 35%. We model the Marshall Plan as a temporary transfer, being known from the outset that will last only 4 periods, with one-third of the aid tied to the provision of infrastructure, therefore we set $m_t = 0.025$ for the first four periods and $\xi = 0.33$.

Figure 4 summarizes the adjustment path of some key economic variables and growth rates. One third of the aid is directly channeled into public investment leading to an increase in the stock of infrastructures. This stock grows almost half a percentage point above its equilibrium growth rate. The untied portion of the transfer increases the resources available for private use allowing for a simultaneous increase in consumption and private investment. Nonetheless the increase in private investment is not enough to compensate for the increase in infrastructures and the ratio of public to private capital begins to increase. This increases the marginal product of private capital leading to a period characterized by an increasing investment rate that reduces the level of consumption. On average private capital grows more than one fourth of a percentage point above its equilibrium growth rate while the Marshall program is in place. On average the plan increases the growth rate of output by one third of a percentage point during the four years that is in place[13]. At the end of the forth period the resources available for private and public use are again limited by the level of domestic production, as a result the rate of public investment returns to its initial level and the rate of private investment decreases by almost two percentage points. With private capital growing slightly faster than public capital, the rest of the transition is characterized by a

[12] See Gramlich (1994).

[13] The response of output growth to the share of productive government investment in GDP, g, depends crucially in the relation between the optimal g and the current g. In general, the growth-maximizing share of government expenditure is attained where the marginal benefits to productivity just match the unit resource costs of the additional government expenditure. Under Cobb-Douglas technology this just reduces to the condition that the expenditure share equal the production elasticity of the public input. In our example, both the temporary increase in g, and the tied portion of the Marshall plan move temporarily the level of public government expenditure closer to its optimal level.

monotonic decrease in the ratio of public to private capital, private savings and consumption.

Our quantitative results support Milward's (1984) claim that the contribution of the Plan was "greatly exaggerated by the cold war historians". Overall the joint effect of aid and investment in infrastructures is not large enough to represent a significant stimulus.

5. The role of international trade

The potential effects of international trade in growth are well known; expanded trade allows an economy to shift resources into more productive uses, fosters competence limiting the power of domestic monopolies, increases the size of the market enabling important economies of scale to be realized and accelerates the process of technological diffusion. Along these lines, several authors highlight the role of international trade in the post-World War II European experience.

Milward (1984) emphasizes that the combination of an important cluster of technological innovations in the late thirties (TV, washing machine, refrigerators) with the beginning of the process of European integration increased substantially intra-European trade characterized by high technology composition. The increase in trade, by favoring the process of technological diffusion, might accelerate the growth rate of total factor productivity as Llewellyn and Potter (1982) highlight. It is well known that World War II represented a turning point between an interwar period in which autarkic policies where dominant and a period in which trade underwent a strong and sustained increase.

When we turn to specific country studies, Giersch et al. (1993) underline the importance of the German import liberalization, later followed by the formation of the EEC customs union, as a method of opening domestic markets to competitive forces from abroad. As they point out by 1960 West Germany's shares of world imports and exports exceeded those that the much larger German Reich had attained before the war, this factor combined with a favorable evolution of the terms of trade lead to a stage characterized by export-led growth. According to Hennings (1982) one of the outstanding features of the post-war period is the extent to which the role of international trade increased. He stresses the high proportion of German exports with income elasticities above unity and the integration in Western Europe as two of the key factors behind the outstanding German growth record. Van Rijckeghem (1982) reaches similar conclusions in the Dutch case. Saint-Paul (1993) downplays the relevance of trade volume emphasizing the importance of trade structure, where intra-European trade progressively replaced trans-Atlantic trade.

Figure 5 illustrates the evolution of the degree of openness –exports plus imports, measured as a share of national product– for our sample economies. Interestingly, a decomposition of this measure by trade partner allows to identify intra-European trade as the only source for the observed increase. The creation of the EEC and the tariff and quota reforms[14] initiated in 1959 propitiated an environment where intra-European trade increased by a factor of 3 in the following decade and a half, thereafter remaining relatively stable.

These patterns combined with the evidence provided by Warner and Sachs (1995) and Frankel and Romer (1999) on the positive effects of trade on growth suggest the relevance of the process of regional integration as one of the key factors behind the European Golden Age.

5.1 A neoclassical model of trade and growth.

In this section we turn to a simplified version of the model presented by Ben-David and Loewy (1998) that allows us to capture the effects regional integration and trade in technological diffusion. Our economy is populated by an infinitely-lived representative agent, that derives satisfaction from the consumption of two distinct goods, according to the following preference specification,

$$U\left(C_t^D, C_t^F\right) = \frac{1}{1-\sigma}\left(C_t^D\left(C_t^F\right)^{\gamma}\right)^{1-\sigma} \qquad (5.1)$$

where C_t^D denotes the consumption of a domestically produced good and C_t^F denotes the consumption of an imported good with $\gamma > 0$ controlling the satisfaction derived from the latter good. Finally, σ governs the same feature of preferences than in previous models.

Domestic output, $\left(Y_t\right)$, is produced combining capital, $\left(K_t\right)$, and effective labor, $\left(E_t^D N_t\right)$, according to the following neoclassical technology,

$$Y_t = K_t^{\alpha}\left(E_t^D N_t\right)^{1-\alpha} \qquad (5.2)$$

[14] Beginning January 1st of 1959, tariffs where reduced 10% per year and quotas were increased by 20% per year. By 1968, all legal barriers among members where in fact eliminated. See Ben-David (1994) for a complete account of the process of elimination of these barriers.

where E_t^D is the level of technology available to the domestic representative firm at time *t*. Normalizing the price of domestic output to one and denoting price of foreign goods in terms of the numeraire as P^F, we can express the degree of openness as, $v_t = \frac{C_t^D + C_t^F P^F}{Y_t}$. Assuming that the share of knowledge that our economy can access from the technology of its trading partners, $\left(E_t^F\right)$, is an increasing function of the volume of trade we postulate the following law of motion for domestically available technology,

$$\dot{E}_t^D = x\left(v_t E_t^F + E_t^D\right) \qquad (5.3)$$

In autarchy, $v_t = 0$, domestic technology grows at the exogenously determined growth rate, x. But as our economy trades, it becomes exposed to foreign competition and technology experiencing a faster path of technological change. Our underlying assumption is that trade allows for the diffusion of knowledge.

To account for the effects of the EEC we introduce a time varying tariff, τ_t, that decreases at a constant rate exponential rate, $\rho < 0$. We assume that the government in our economy devotes this tariff to non-productive uses. Capital is accumulated out of output net of depreciation, δ, after allowing for domestic consumption and the purchase of foreign goods according to the following law of motion,

$$\dot{K}_t = Y_t - C_t^D - \left(1 + \tau_t\right) C_t^F P^F - \delta K_t \qquad (5.4)$$

5.2 Macroeconomic Equilibrium.

We assume that the representative agent takes the path of technological progress as independent of her choices, the optimality conditions for the previous problem, where β is the rate of time preference and λ is the co-state variable associated to the capital stock, are

$$\left(C_t^D\right)^{-\sigma} \left(C_t^F\right)^{\gamma(1-\sigma)-1} = \lambda_t \qquad (5.5a)$$

$$\gamma\left(C_t^D\right)^{1-\sigma} \left(C_t^F\right)^{\gamma(1-\sigma)-1} = \lambda_t \left(1 + \tau_t\right) P^F \qquad (5.5b)$$

$$\alpha \frac{Y_t}{K_t} - \delta = \beta - \frac{\dot{\lambda}_t}{\lambda_t} \qquad (5.5c)$$

together with the transversality condition

$$\lim_{t\to\infty} \lambda_t K_t e^{-\beta t} = 0 \qquad (5.5d)$$

(5.5a) equates the marginal utility of domestic consumption to the shadow value of capital, (5.5b) equates the marginal utility of imported consumption to the shadow value of capital adjusted for tariffs and foreign prices and (5.5c) is an intertemporal allocation condition equating the marginal product of capital to the rate of return on consumption.

Finally, to evaluate the effects of the European Common Market it is sensible to assume that the levels of technology were similar between the founding members, and by definition intra-European trade is balanced, since the imports of one member are the exports of some other. Under these circumstances the endogenous growth rate of technology becomes,

$$\hat{E}_t^D = x\left(\frac{2\gamma}{1+\tau_t}\frac{C_t^D}{Y_t}+1\right) \qquad (5.6)$$

Following our previous definition of a balanced growth path it is convenient to write the dynamic system in terms of the following stationary variables, $k \equiv \frac{K}{E^D N}$ $c \equiv \frac{C}{E^D N}$. Combining these definitions with (5.2), (5.4), (5.5) and (5.6), we reach the following system of differential equations where for simplicity we suppress the time subscripts,

$$\hat{c}^D = \frac{1}{\sigma-\gamma(1-\sigma)}\left(\alpha k^{\alpha-1} - \delta - \gamma(1-\sigma)\frac{\dot{\tau}}{1+\tau}\right) - x\left(\frac{2\gamma}{1+\tau}\frac{c^D}{k^\alpha}+1\right) \qquad (5.7a)$$

$$\hat{k} = k^{\alpha-1} - (1+\gamma)\frac{c^D}{k} - \delta - x\left(\frac{2\gamma}{1+\tau}\frac{c^D}{k^\alpha}+1\right) \qquad (5.7b)$$

That together with the time path of tariffs imposed by the Treaty of Rome, $\hat{\tau} = \rho$, fully determines the dynamic behavior of our economy

Imposing the steady state condition $\dot{c}^D = \dot{k} = \dot{\tau} = 0$, we can solve for the steady state value of the tariff $\tau^* = 0$. Combining (5.7a) and (5.7b) leads to a polynomial equation on k^* with only one of the roots satisfying (5.5d). To proceed with our analysis we linearize (5.7) around its steady state, the resulting system exhibits saddlepoint behavior for a wide range of parameter values and we shall focus our attention on that case, as being the plausible one.

5.3 Numerical Analysis.

We calibrate our model to reproduce some of the key features of our sample of economies in post-war period. The rates of time preference and depreciation and the elasticities of intertemporal substitution and output to capital are set equal to those in section 3. As a result, before the process of economic integration, the steady state interest rate is around 7.5 %, savings out of disposable income is 22.5% and the exogenous rate of technological change is set so that the equilibrium growth rate is 2 %. This model has two additional parameters, ρ and γ, the rate of decrease of tariffs and the relative importance of imported goods in the determination of welfare respectively. The former is pinned down by the conditions set in the Treaty of Rome that phase out the existing trade barriers by 1970. The latter is set in such a way that after economic integration the steady state level of intra-European openness is close to 20%, the average level in our sample economies between 1970 and 1980. Finally we need to choose the initial level of tariffs. Data on trade barriers is ambiguous and difficult to interpret. Calculations based on Balassa (1965) suggest that the level of effective tariff protection in our sample economies in 1958 ranged from -9% (pig iron and ferromanganese) to 58% (textile fabrics), excluding the effects of subsidies, quotas and administrative barriers. Calculations based on the same source lead to an effective tariff rate in consumer goods in the range of 40%. An alternative calibration approach will choose the initial tariff rate to be consistent with the degree of intra-European trade of our sample economies before 1959. We follow this alternative.

In the following exercise we assume that our economy is moving along a stable growth path until 1959, where the provisions eliminating tariff protections are introduced, at that moment forward looking agents fully anticipate the future evolution of tariffs and re-optimize their consumption choices[15].

Figure 7 reproduces the results of this exercise. The first panel compares the actual path of the tariffs reductions reproduced from Jensen (1968) and Ben-David (1993)

[15] An alternative approach would assume that the change in tariffs was anticipated, under these circumstances the jump in consumption would take place when the information becomes public.

with the one simulated by our model. The second panel compares the actual and simulated paths of the degree of openness. Before economic integration, along the initial stable growth path, the degree of intra-European openness remains constant at a level slightly above 8%. The decrease in tariffs increases the resources available for private use. Under those circumstances consumption of domestic and imported goods increases, the change in relative prices lead to an increase in the share of imported good relative to domestic goods. The initial increase in consumption does not fully absorb the increase in disposable income and investment increases at impact, the increase in investment leads to a process of capital accumulation, but as the degree of openness of our economy increases, the rate of technological change increases and saving does not increase fast enough to prevent the (normalized) capital stock from falling. The rest of the transition is characterized by a monotonic decline of capital, output and consumption until the new steady state characterized by a lower level of normalized capital is reached. The change in output per capita is driven by two forces; the growth in technology and the process of capital accumulation. In the first periods of the transition the process of capital accumulation increases the growth rate of output by almost half a percentage point relative to its initial steady state value. By the time that capital begins to decumulate, the rate of technological change is fast enough to prevent the growth rate of output to fall below its previous equilibrium level, nonetheless the process of capital dilution depresses the growth rate of output per capita that remains below its new intertemporal equilibrium level of 2.2% the rest of the transition. This growth effect of trade is in line with the calculations of De Long (1997) for the same period.

Under our assumptions, we can conclude that the role of the integration process in the European growth record, although significant, is far from providing a full account of the events.

6. Conclusions

In the two decades that followed World War II, Western European economies witnessed an uninterrupted period of growth and stability. Since then, economists have been trying to understand the sources behind this growth miracle. In this paper, we present fully specified models to quantify the contributions of the most relevant hypothesis presented in this literature.

Our results suggest that the “stylized facts” of the European Golden Age are difficult to rationalize in terms of the usual suspects: Large migrations from agriculture to manufactures, the Marshall Plan and public investment, and intra-European trade. On one hand these results strengthen our confidence in the relevance of the reconstruction hypothesis, the identifying assumption behind Alvarez-Cuadrado (2004), on the other hand these findings refine our understanding of the post-war period by providing quantitative evidence on the relative magnitude of some of the additional forces at work.

Furthermore, our results provide some interesting insights on the substantial reduction in the growth rate of output during the seventies that may be worth exploring. In the Western European context, standard quantifications of the productivity slowdown that fail to account for the important role played by internal migrations, might overstate its true dimension as pointed out by Temin (2002).

Tables and Figures

	France	Germany	Italy	Austria	Nether.	Canada	Austral.	US
Growth rates	**4.09**	**5.69**	**5.18**	**5.17**	**3.38**	2.64	2.48	2.47
1950-1960	3.84	7.73	5.40	6.21	3.12	2.15	1.84	2.15
1960-1970	4.36	3.45	4.93	4.02	3.67	3.19	3.17	2.83
$\Delta(K/Y)_{55-70}$	**19%**	**17%**	**13%**	**22%**	**15%**	-7%	-2%	-5%
ΔSav_{50-62}	**45%**	**25%**	**39%**	**12%**	**23%**	0%	5%	-8%
ΔSav_{62-65}	**4%**	**-3%**	**-10%**	**4%**	**-3%**	10%	1%	4%
$\Delta(wL/Y)_{50-70}$	**11.44%**	**11.62%**	**19.04%**	**0.17%**	**12.08%**	-2.66%	-3%	3.03%

Table 1 Some stylized facts of the transitional path after a large destruction of capital. Growth rates are reported in per year terms.

Preference Parameters	$\sigma = 2.5; \beta = 0.02$
Technological Parameters	$B_a = B_m = 1; \alpha = 0.55, 0.75, 0.95; \mu = 0.4;$ $\gamma_a = 0.04; \gamma_m = 0.02; \delta = 0.05$
Growth rate	2 %
Saving rate	0.24
Output-Capital ratio	0.3
Capital share	0.40
Net return on capital	7%

Table 2. Benchmark parameters and steady state values section 3.

Preference Parameters	$\sigma = 2.5; \beta = 0.02$
Technological Parameters	$\eta = 0.2$, $\alpha = 0.22, \delta_K = 0.05$
Gov. Exp. Parameters	$g = 0.15$
Marshall plan parameters	$m_t = 0.025, \xi = 0.15$
Growth rate	2 %
Private Saving rate	0.39
Public-Private Capital ratio	0.38

Table 3. Benchmark parameters and steady state values for section 4.

Preference Parameters	$\sigma = 2.5, \gamma = 0.14, \beta = 0.02$
Technological Parameters	$\alpha = 0.4, \delta = 0.05, \rho = -0.2$
Growth rate	2%, 2.2%
Saving rate (out of Y^{Disp})	22.5%, 22%
Output-Capital ratio	0.32
Capital share	0.40
Net return on capital	7.5%, 8%
Intra-European Openness	8%, 19%

Table 4. Benchmark parameters and steady state values for section 5 before and after integration.

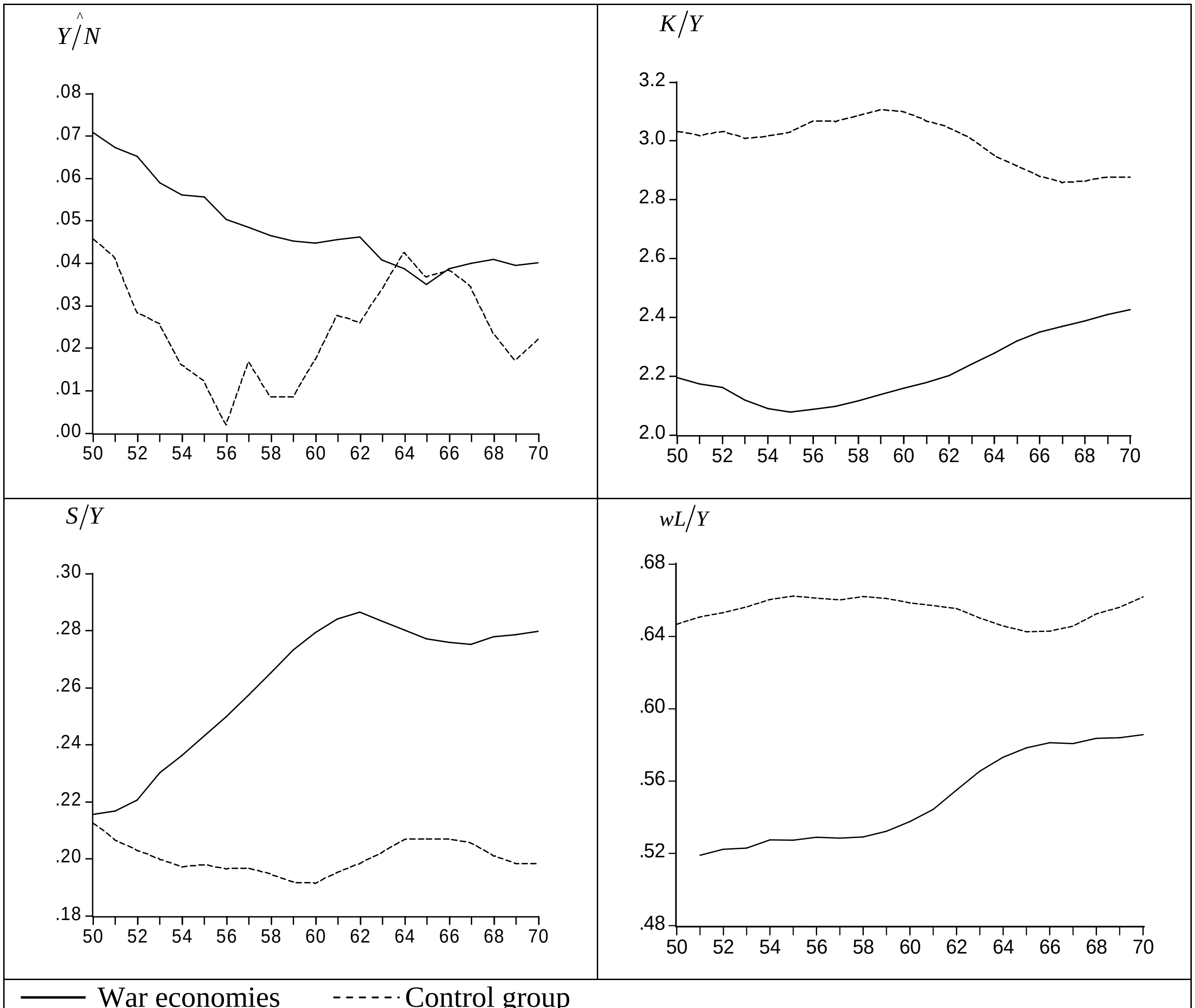

Figure 1. Evolution of key economic variables after World War II.

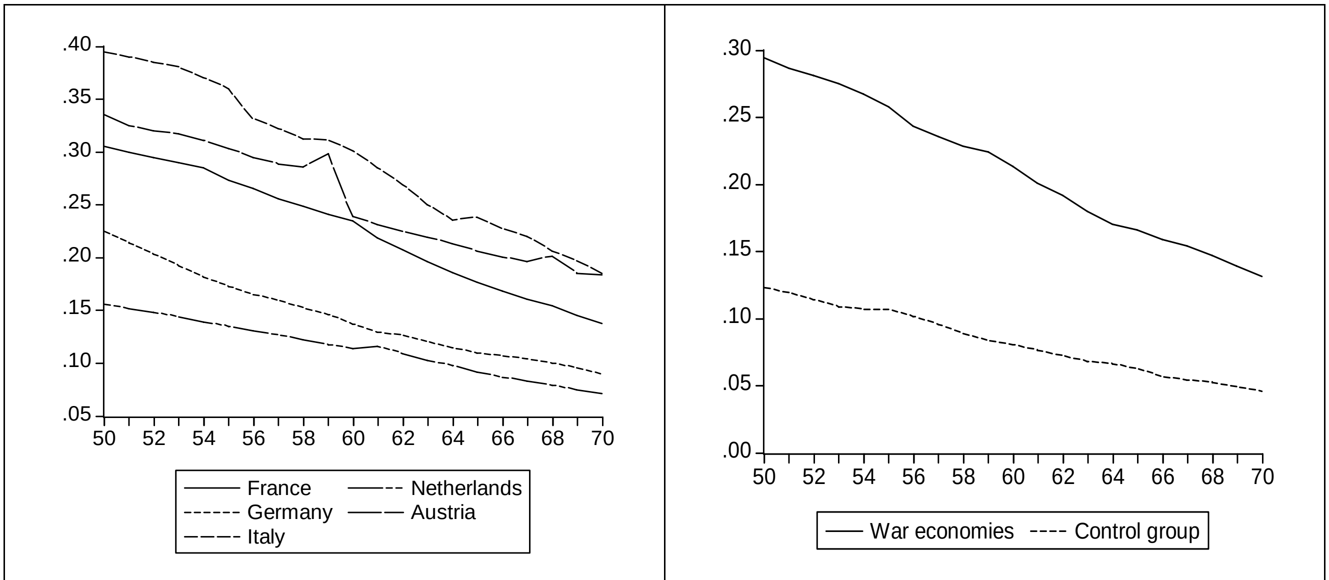

Figure 2. Share of labor force devoted to agriculture.

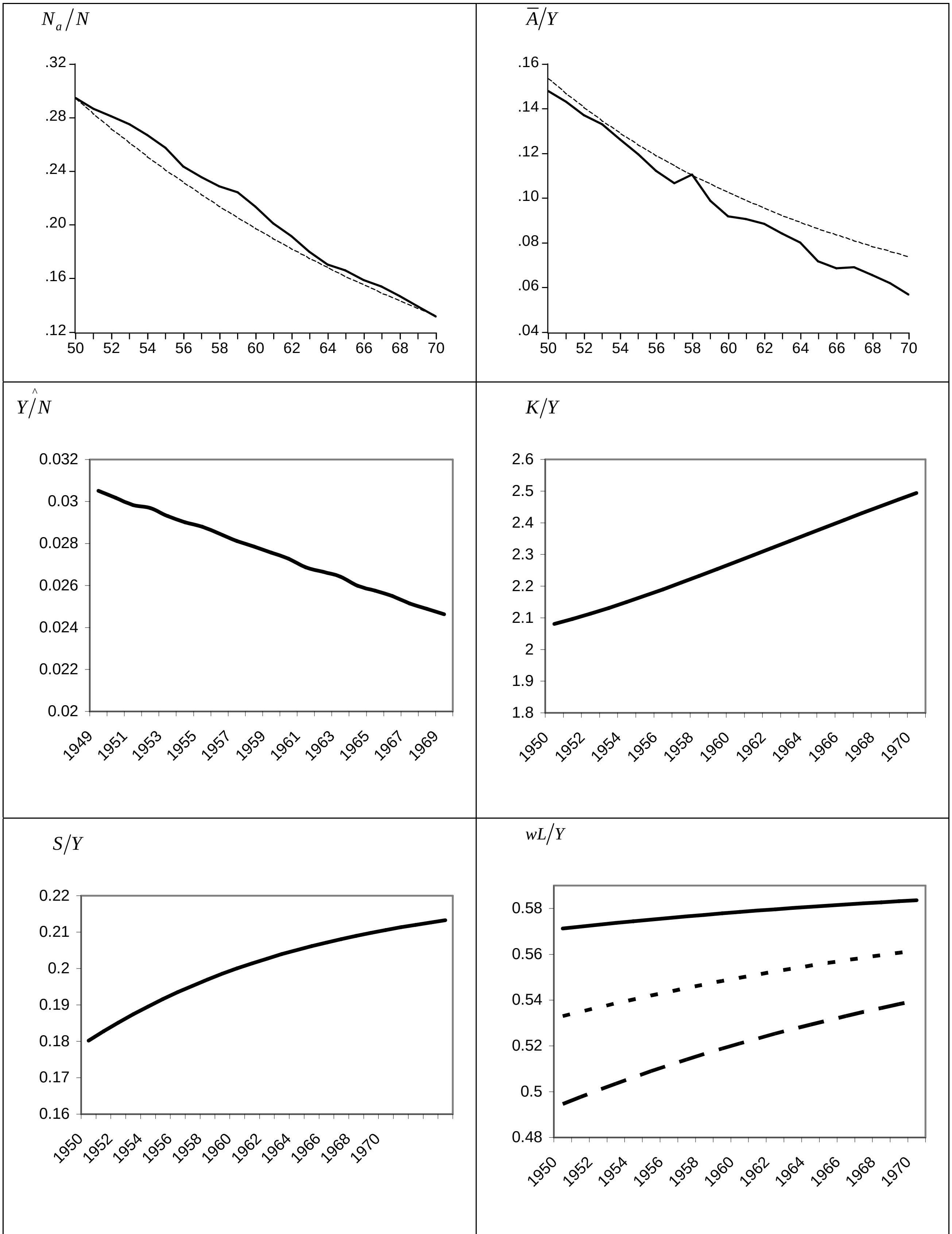

Figure 3. Transition from agriculture to manufacturing.

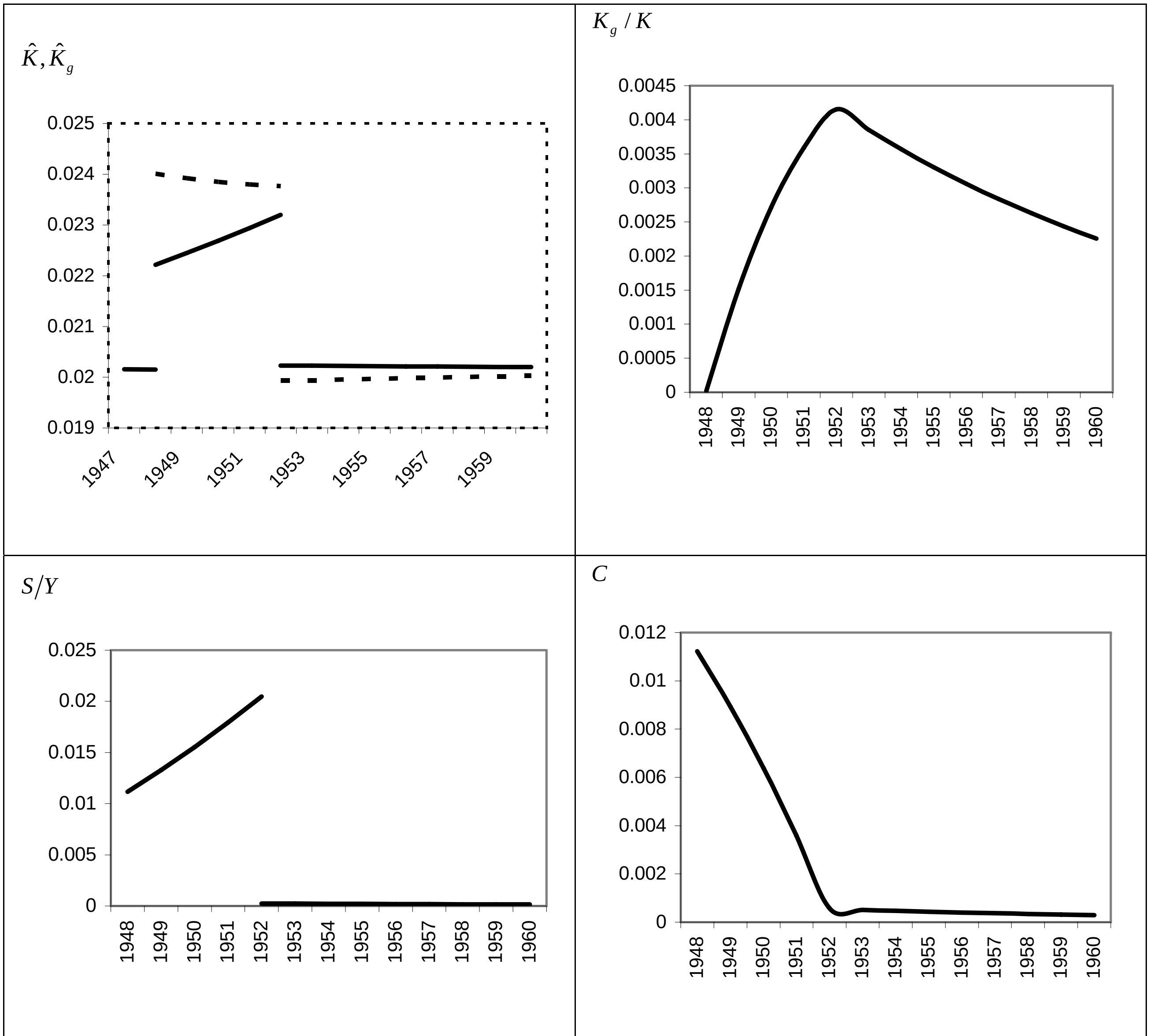

Figure 4. Transitional dynamics of an economy with a temporary transfer. Deviations from steady state.

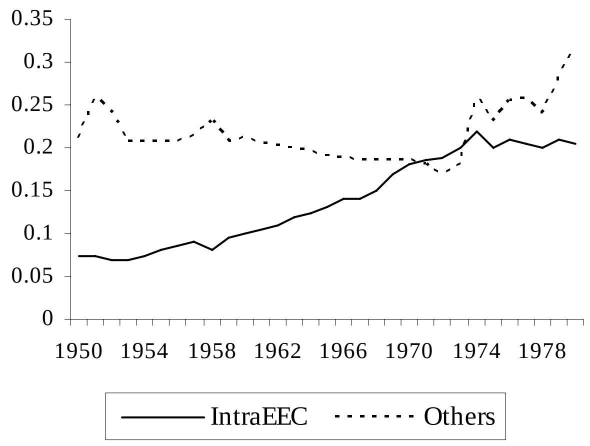

Figure 5. Evolution of the degree of openness.
All the figures exclude Austria.

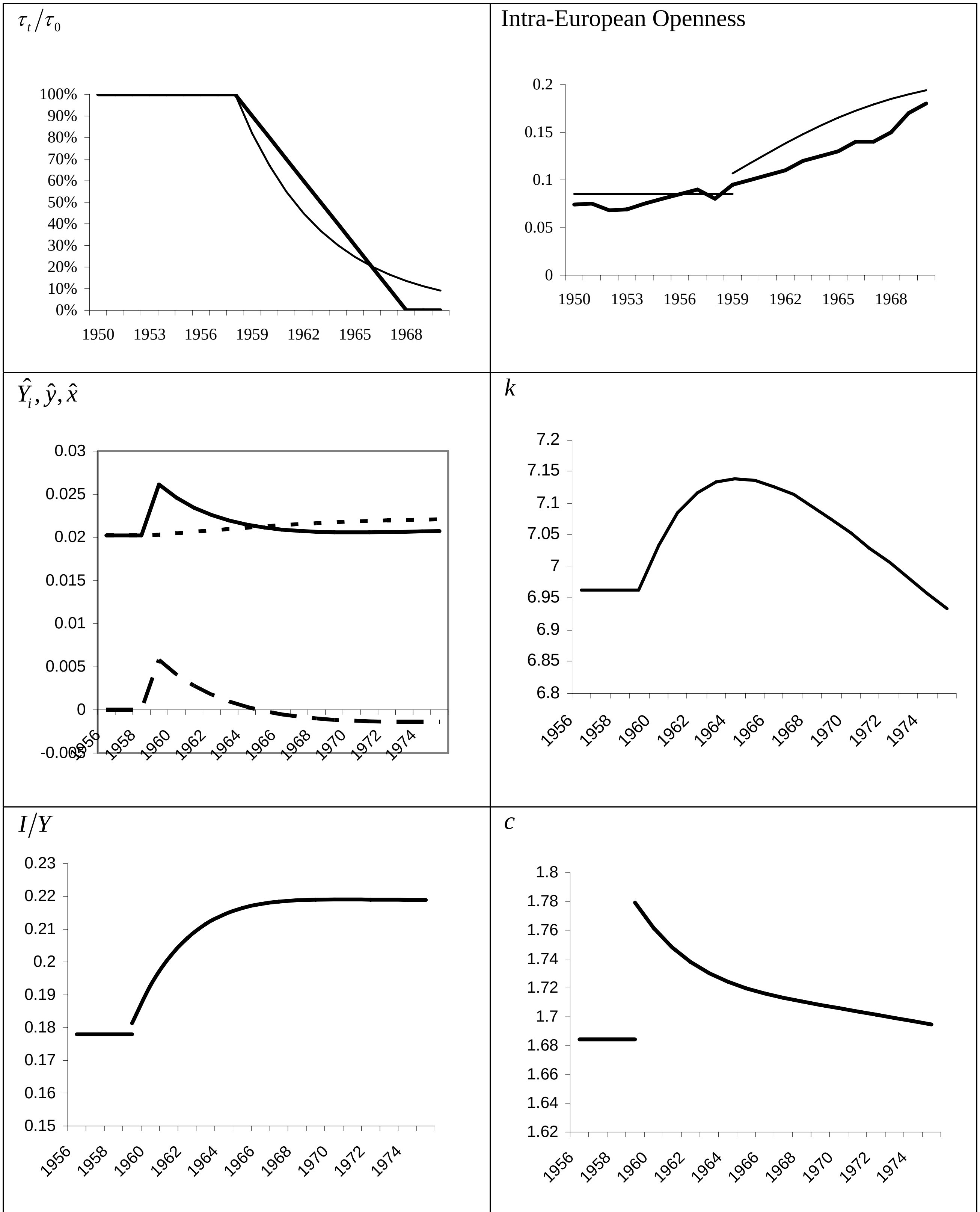

Figure 6. Transitional dynamics of the European integration.

Appendix: Data Sources and Programs

For expositional purposes, we choose to report five-year moving averages for each country and variable. Aggregate data is calculated using real GDP Geary-Khamis PPP adjusted US$ 1990 as the aggregation weight.

Section 2

Data from Alvarez-Cuadrado (2004)

Section 3

Data on employment share on agriculture is from the following sources; OECD (1963, 1972) and GGDC (2004). We use table *II. Labour force* entry *5. Civilian employment* to complete the data on civilian employment provide by GGDC (2004). Unemployment is from table *II. Labour force* entry *4. Unemployed*. Population employed in the agricultural sector is from table *III. Civilian Employment* entry *2. Agriculture, hunting, forestry, and fishing.* We calculate the share of agriculture in the labor force as (*Agriculture, hunting, forestry, and fishing/(Civilian employment + Unemployed)*.

Data on the weight of agriculture on GDP is from OECD (1969, 1973). We use table *3. Gross domestic product at market prices by industry of origin* entry 1. *Agriculture, forestry and fishing* and entry *15. Gross domestic product at market prices* . The share of agricultural output is calculated as (*1. Agriculture, forestry and fishing)*/(*15. Gross domestic product at market prices*).

Section 4

The figures about the Marshall Plan are from Milward (1984) pg. 90-113. Data on government expenditure share of GDP is from the following sources is from Heston et al. (2002) (*kg / government expenditure in constant prices*).

Data on the weight of defense expenditure as share of government expenditure is from OECD (1969, 1973). Using table *1. National product and expenditure* entry *2.a Defense* and entry *2. Government current expenditure*. Non-military government expenditure is then calculated as (*kg / government expenditure in constant prices*)*(1-((*2.a Defense*)/ (*2. Government current expenditure*)).

Section 5

We use a measure of openness in current prices (*openc / Openness in current prices*) from Heston et al. (2002). The data on intra-European trade is from ICPSR 7628 Direction of Trade of the International Monetary Fund.

Programs

The programs for section 4 and 5 are coded in Mathematica. The programs for section 3 are coded in Matlab. All of them are available from the author.

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