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A Quantitative Exploration of the Golden Age of European Growth

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Abstract

Income per capita in some Western European countries more than tripled in the two and a half decades that followed World War II. The literature has identified several factors behind this outstanding growth episode, specifically; structural change associated with large migrations from agriculture to nonagricultural sectors, the Marshall Plan combined with the public provision of infrastructure, the surge of intra-European trade, and the reconstruction process that followed the devastation of the war. This paper is an attempt to formalize and quantify the direct contribution of each one of these factors to growth during the European Golden Age. Our results highlight the importance of reconstruction growth and structural change, and point to the limited role of the Marshall Plan, and the late contribution of intra-European trade.

JEL classification codes: O40, N14, C68
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1. Introduction

The group of Western European economies most directly affected by the devastation of World War II experienced 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 the Golden Age of European growth (1948-1973). Our objective is to build a fully specified model to assess the relative contribution to growth of the main factors highlighted in this literature.

Between 1948 and 1973 income per capita grew at an average yearly rate of 5.8 % in West Germany, 5.0 % in Italy, 4.4% in France, 3.7% in Holland and 3.6% in Belgium. At these rates German income per capita was doubling every 12 years, Italian and French ones every 15 years, and Dutch and Belgium per capita income needed less than two decades to double.

A number of theories offer explanations for this outstanding episode of growth and stability. A first group of authors, lead by Kindleberger (1967), Saint-Paul (1993), Giersch, et al. (1993), Temple (2001) and Temin (2002), highlight the importance of structural change. According to their view, the large reallocation of resources, from low-productivity agricultural activities to a highly productive manufacturing sector, is the crucial factor behind this growth episode. Janossy (1971), Christiano (1989), Dumke (1990) and Alvarez-Cuadrado (2008) argue that the Golden Age is the result of the transitional dynamics associated with the imbalance between physical capital and labor left behind by the war. A third stream of literature, represented by Mayne (1973), Gimbel (1976) and Mee (1984), emphasizes the Marshall Plan and public investment as a key stimulus to growth. Finally Jensen (1967), Llewellyn and Potter (1982), Hennings (1982), Van Rijckeghem (1982), Milward (1984), and Giersch et al. (1993) point to the relation between growth in the Golden Age and the surge of intra-European trade, after a period of relative autarky that goes back to the beginning of the First World War[1]. Following

[1] The literature has identified other potential factors behind the Golden Age. 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. Eichengreen (2007) highlights the role of institutions (trade unions and employers' associations) combined with an important technological gap with the US. In his view the Golden Age was driven by the process of catch-up to the technological

these authors we limit our analysis to West Germany, Italy, France, Holland and Belgium, countries where to a large extent all these factors were present[2].

In this paper we present a fully specified model that allows us to quantify the relative contribution of each one of the aforementioned factors to the post-war growth record. Our basic framework is a variant of a one-sector neoclassical growth model extended to include an explicit agricultural sector. Improvements in agricultural technology, combined with a limited demand for food, drive the process of structural change. Production in the manufacturing sector requires the use of public infrastructure, following Barro (1990). Trade, by exposing the economy to foreign ideas and competition, influences the level of technology available for domestic production. Finally, to capture the role of the Marshall Plan we allow for a unilateral foreign transfer that relaxes the constraint imposed by the domestic productive capacity. Using actual data on Marshall Aid, government investment, tariffs and initial share of labor in agriculture we simulate our model and explore its transitional dynamics after a large destruction of capital. We compare the resulting time series with the data along several dimensions. Our stylized specification captures very well the path of sectoral labor migration, the evolution of the share of agriculture in total output, the surge in intra-European trade and the growth rate of income per capita. The correlation coefficient between the actual and the simulated growth rate is close to 0.93. More importantly, our model not only captures the trend in growth but also captures a substantial amount of the variation. The correlation coefficient between the de-trended actual growth rate and the de-trended model growth rate is 0.4. What makes these results even more impressive is the fact that they are obtained in the absence of exogenous time-varying productivity shocks.

We use this framework to conduct a series of counter-factual experiments in which we shut down, one at a time, the alternative sources of growth under consideration.

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frontier. The latter two arguments fall within the group of explanations for the European miracle that stress the importance of a steady state gap, as the reconstruction hypothesis.

[2] The growth rates of other European countries where some of these factors were absent were systematically lower over our period of interest. Estimates for Britain suggest a post-war steady state gap below 10% and a share of agricultural labor of 5%. The average growth rate of Britain during the Golden Age was 2.4%. The destruction of the Swedish and Danish capital stocks was very limited and their average growth rates were 3% over our period of interest. See Alvarez-Cuadrado (2008) for a comparison of our sample economies with other advanced economies during the Golden Age.

We measure the relative contribution of a specific factor as the difference between the growth rate in the complete model and the growth rate in the same model when that factor is absent. Our results highlight the importance of reconstruction growth and structural change during the 1950s. Almost three percentage points of growth can be attributed to the combined effect of these two factors. During the 1960s, the contribution of reconstruction growth falls below half a percentage point, while sectoral labor migrations still contribute close to one percentage point. The direct contribution of the Marshall Plan is limited in time and scope, amounting to no more than a quarter of a percentage point of additional growth during the early 1950s[3]. Finally, in the decade following the 1957 creation of the Common Market, the associated growth effects were unexpectedly small. Towards the end of the Golden Age, the Common Market contributes to one fourth of a percentage point of additional growth with its full effects being felt only two to three decades after its creation.

Our paper complements a vast literature that has not yet reached a consensus on the causes of growth during the European Golden Age. On the one hand, the abundant historical accounts, with their qualitative approaches, are often inconclusive. On the other hand, formal econometric exercises, which could quantify the effects of different sources of growth, face important identification problems. As a result, we believe that an explicit general equilibrium model is ideally suited to study this historical episode. This approach allows exploring all the factors of interest simultaneously, quantifying not only their relative contributions but also allowing for important interactions usually ignored in the existing literature.

The paper is organized as follows. Section 2 discusses the four alternative hypotheses presented in the economic literature to explain the Golden Age of European growth. Section 3 presents the model and derives the macroeconomic equilibrium. In Section 4 we conduct numerical exercises and several counterfactual experiments. The conclusions are summarized in Section 5.

2. The European Golden Age: Alternative Explanations

[3] Nonetheless our quantitative exercise misses other positive effects of the plan, such as allowing governments to guarantee the continuity of democratic and market-oriented institutions through the provision of basic consumption needs in the hardships of the after-war years.

The Golden Age was a period characterized by rapid growth and macroeconomic stability. In our sample of economies income per capita almost quadrupled over the two and a half decades that followed World War II. The economic literature has developed several hypotheses to explain this outstanding episode.

A first group of authors focuses on the substantial reallocation of resources, from agricultural to nonagricultural activities, which took place in post-war Europe, as the key factor behind this outstanding growth record. Both institutional and technological factors may have played a role in this process. For instance, Olson (1982) argues that the war broke all sorts of preexisting ties that kept people in the rural areas and thus stimulated these intense migrations. The introduction of new crop varieties, fertilizers and pesticides are examples of technological factors that substantially increased the level of productivity in agriculture, releasing labor for alternative uses.

In a similar manner, Kindleberger (1967) suggests that the major factor shaping the remarkable economic growth of post-war Europe was the availability of a large supply of labor. Saint-Paul (1993) points to 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. In the German context Giersch et al. (1993) highlight the importance of internal migrations, mainly among refugees from the East who were initially allocated in rural areas. Temin (2002) argues that the high growth of the European Golden Age reflects the end of the misallocation of resources generated by the interwar autarkic model. In his view, 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 associated with important gains in productivity. For instance, in Italy the share of population devoted to agriculture decreased from 42% in 1948 to 17% in 1973. The corresponding numbers for France were 36% and 12%. On average close to 20% of the population in our sample economies left the agricultural sector during the Golden Age. As a benchmark for comparison, in 1948 only 5% and 13% of the British and American labor force, respectively, were employed in agriculture.

A second stream of literature emphasizes the reconstruction effort that followed War World II as the key factor behind the Golden Age. This argument is best illustrated in the context of the transitional dynamics of the standard one-sector neoclassical growth model. In this model, when the initial capital stock is below its steady state level the marginal product of capital is high. The high return on investment not only implies that each additional unit of capital is very productive but also that agents find it optimal to deter consumption, increasing saving. As a result, the highly productive capital combined with the high investment rate leads to a transition characterized by fast, and slowly decreasing, capital accumulation and growth. Along these lines, several authors associate the war destruction with a substantial steady state gap. As Crafts and Toniolo (1996) point out, during the war years, the productive effort of more than an entire generation was lost with per capita income returning to the levels of the turn of the century. Janossy (1971) argues that the European post-war miracle is the result of the reconstruction process associated with the imbalance between physical capital and labor left behind by the conflict. Christiano (1989) and more recently Chen et al. (2006) subscribe to similar arguments in their attempt to explain the post-war saving behavior of the Japanese economy. Gilchrist and Williams (2004) and Alvarez-Cuadrado (2008) compare the evolution of key economic variables during the European Golden Age with the transitional dynamics of several growth models after a large destruction of capital. Finally, Dumke (1990) provides direct econometric evidence for the reconstruction hypothesis. Using data from 16 OECD countries, he finds that the reconstruction hypothesis accounts for roughly one percentage point per year of growth for Germany up to 1970.

During the Cold War years, a third group of authors sought to prove a cause-effect relation between the Marshall Plan and the remarkable economic performance of the recipient economies. The Marshall Plan transferred $13 billion in aid from the United States to Western Europe between 1948 and 1951. In absolute terms, over the four-year period of the plan, $2.3 billion went to France, $1.2 billion to Italy, around $0.7 billion to Belgium, $1.1 billion to the Netherlands and $1.5 billion to Germany. Aid was not allocated in any fixed proportion to national income but on average the per year transfers amounted to 2.5% of French GDP, 2.2% for Italy, 3.7% for Belgium, over 4% for the

Netherlands and 1.1% for Germany according to the calculations of the Bank of International Settlements reported by Milward (1984).

Mayne (1973), Gimbel (1976) and Mee (1984) are the main supporters of the crucial impact of the Plan. They 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. In DeLong and Eichengreen (1991) terminology, this "folk wisdom" of international relations about the Plan is not supported by empirical evidence. Similarly, Milward (1984) argues that the post-war European growth record would not have been very different in the absence of the Plan.

As a first step to assess the economic impact of the Plan, it is important to understand the allocation of the aid. Eichengreen and Uzan (1991) estimate that out of each dollar of aid some 35 cents went into increased investment, relaxing the constraint imposed by the limited domestic productive capacity. These investments were mainly directed towards infrastructure development, such as electricity, gas, power supply, transport and communications.

Beyond the scope of the Marshall Plan, Saint-Paul (1993) highlights the positive role played by the French government in 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 built the Italian road system. As suggested by these authors, public provision of infrastructure in combination with the Marshall Aid played an important role for growth during the Golden Age.

Finally, Jensen (1967), Llewellyn and Potter (1982), Hennings (1982), Van Rijckeghem (1982), Milward (1984), and Giersch et al. (1993) emphasize the relation between technological innovations, intra-European trade and export-led growth as a key determinant of the Golden Age. Milward (1984) argues that the combination of an important cluster of technological innovations in the late 1930s (TV, washing machine, refrigerators) with the beginning of the European integration process increased substantially intra-European trade that is characterized by its high technology composition. As Llewellyn and Potter (1982) highlight, the increase in trade, by favoring the process of technological diffusion might have accelerated the growth rate of total factor productivity. The end of the war represented a turning point between an interwar period in which autarkic policies were 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. 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 emphasizes that the high proportion of German exports with income elasticities above unity and the greater integration with Western Europe are two of the key factors behind the German growth record. Van Rijckeghem (1982) reaches similar conclusions in the Dutch case. Saint-Paul (1993) downplays the relevance of trade volume, emphasizing instead the importance of trade structure, where intra-European trade progressively replaced trans-Atlantic trade.

The post-war European trade data is consistent with these arguments. As a result of the tariff and quota reductions associated with the Treaty of Rome, the share of intra-European trade in GDP more than doubled between 1959 and 1973. Specifically, this increase in intra-European trade accounts for almost 85% of the overall increase in trade for our sample of economies.

There is little doubt that each of these explanations has its own merits and empirical support. But given the disparity of these theories we believe that a fully specified general equilibrium model that encompasses simultaneously the different sources of growth will represent a major contribution to our understanding of the Golden Age. In recent years, such models have been applied successfully to several historical episodes (Ohanian (1997), Cooley and Ohanian (1997), Cole and Ohanian (2004), and Chen et al. (2006)). This approach allows us not only to quantify the relative importance of each factor involved but also to capture the potential interactions among them. This is especially relevant in a context like the one we examine, where narrative approaches might be unconvincing and standard econometric methods face substantial identification problems.

3. The Analytical Framework

Our structure builds on previous work by Laitner (2000) and Gollin et al. (2002). Its main building block is a version of the one-sector neoclassical growth model extended to include an explicit agricultural sector. Improvements in agricultural technology combined with a limited demand for food push labor from agriculture to the manufacturing sector. Trade is limited to manufactured products and, by exposing the economy to foreign ideas and competition, influences the rate of technological change available for domestic production. The abstraction from trade in agricultural products is consistent with the fact that agricultural goods were temporarily exempted from the tariff and quota reductions which governed the rest of the internal EEC trade[4].

Finally, to capture the role of foreign aid and public investment we allow for a unilateral foreign transfer and a production technology that uses public infrastructure as a necessary input, in the spirit of Barro (1990).

3.1. Preferences

Our economy is populated by an infinitely lived representative agent that derives utility from the consumption of a domestically produced non-agricultural good, C_t^M, a non-agricultural imported good, C_t^{M*}, and a non-storable agricultural good, C_t^A, according to the following Stone-Geary specification[5],

$$\begin{aligned} U\left(C_t^M, C_t^{M*}, C_t^A\right) &= C_t^A && \text{if } C_t^A < \overline{A} \\ &= \left(\ln C_t^M + \gamma \ln C_t^{M*}\right) + \overline{A} && \text{if } C_t^A \geq \overline{A} \end{aligned} \tag{1}$$

with $\gamma > 0$ controlling the satisfaction derived from imported goods.

In order to induce structural change our preferences are non-homothetic. The income elasticity of food demand falls to zero once the threshold level $\overline{A}$ is reached. This specification captures an extreme version of Engle law of demand in line with the

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[4] This exemption led to the Common Agricultural Policy which limited intra-European trade of agricultural commodities by means of domestic production quotas.

[5] We have in mind an imported good that is "made in Europe", i.e. it is manufactured by one of the founding members of the Common Market. For simplicity trade outside the Common Market is left unmodeled.

evidence presented by Houthakker (1957). This feature of preferences has long been emphasized in the literature on sectoral reallocation; see for instance Matsuyama (1992), Laitner (2000) and Gollin et al. (2002).

Lifetime utility is given by,

$$\int_0^\infty U\left(C_t^M, C_t^{M*}, C_t^A\right) e^{-\rho t} dt \tag{2}$$

where ρ is the subjective discount factor. Since we abstract from population growth the distinction between per capita and aggregate variables is trivial.

3.2. The Agricultural Sector

Food production, Y_t^A, takes place combining a fixed amount of land, T, and technology-augmented labor, $E_t^A N_t^A$, according to the following Cobb-Douglas specification,

$$Y_t^A = \left[E_t^A N_t^A\right]^\mu T^{1-\mu} \tag{3}$$

The efficiency of labor in agriculture, E_t^A, grows exponentially at the exogenous rate x_A. Following Laitner (2000) and Gollin et al. (2002) we abstract from capital in this sector. The reasons for this simplification are twofold; on the one hand the introduction of capital has limited effects in our numerical results, on the other hand there is ample evidence of the low degree of capital intensity in agriculture relative to the manufacturing sector in our sample of economies. For instance, Eckstein (1951) reports the shares of capital in agriculture for Belgium, France and Italy to be 3.5%, 11% and 10.2%, while the respective shares of labor in that sector were 17%, 36% and 42%.

Our representative agent is endowed with one unit of time that is allocated between the two productive activities: employment in agriculture, N_t^A, and employment in the manufacturing sector, N_t^M. Under the assumption that the initial level of agricultural productivity is high enough for both sectors to be active, $\left[E_0^A\right]^\mu T^{1-\mu} > \overline{A}$, migrations are driven by the following law of motion,

$$\hat{N}_t^M \equiv \frac{\dot{N}_t^M}{N_t^M} = \frac{x_A N_t^A}{1 - N_t^A} \tag{4}$$

Technological improvements in the agricultural sector together with a limited demand for food are the only source behind labor migration in our model. In the limit agriculture's employment share shrinks to zero and the model converges to a variant of the one-sector neoclassical growth model that we introduce in the next subsection.

3.3. The Manufacturing Sector

The manufacturing sector produces output, Y_t^M, combining private capital, K_t, public capital, K_{gt}, and technology-augmented labor, $E_t^M N_t^M$, according to the Cobb-Douglas production function,

$$Y_t^M = K_t^\alpha \left[E_t^M N_t^M \right]^{1-\alpha} K_{gt}^\beta \qquad \alpha + \beta < 1 \tag{5}$$

The production function exhibits constant returns to scale in the two private inputs, K_t and N_t^M, and increasing returns to all three factors. This specification embodies a role for productive government expenditure following Barro (1990) in the non-scale structure studied by Eicher and Turnovsky (1999, 2001).

In the absence of trade, technological change in the manufacturing sector increases the efficiency of labor, E_t^M, at the exogenous rate x_M. Normalizing the price of domestic manufacturing output to one and denoting the relative price of foreign goods by P^{M*}, we define the degree of openness for our economy as,

$$v_t = \frac{C_t^X + P_t^{M*} C_t^{M*}}{Y_t^M} \tag{6}$$

where C_t^X are exports. Following Ben-David and Loewy (1998) we assume that the share that our economy can access from the technology of its trading partners, E_t^{M*}, is an increasing function of the volume of trade. As a result we postulate the following law of motion for domestically available technology,

$$\dot{E}_t^M = x_M \left(\eta v_t E_t^{M*} + E_t^M \right) \tag{7}$$

where η captures the effect of trade on growth. In autarchy, $v_t = 0$, domestic technology grows at the exogenously determined growth rate, x_M. As our economy trades, it becomes exposed to foreign ideas and competition experiencing a faster path of technological change.

In order to explore the effects of the Marshall Plan, we allow our economy to receive a temporary transfer. We model this transfer as a fraction of manufacturing output, $m_t Y_t^M$. Furthermore, we allow a percentage of the transfer, ξ, to be tied to the provision of public infrastructure with the rest being a pure transfer, $m_t \left(1-\xi\right) Y_t^M \equiv T_t$. Aside from foreign aid, we assume that the economy is closed to international capital flows, and therefore domestic conditions uniquely determine the equilibrium interest rate[6].

The government in our economy finances the provision of public infrastructure from three sources: tariff revenues, $\tau_t C_t^{M*} P_t^{M*}$, the tied proportion of the Marshall aid, $\xi m_t Y_t^M$, and income tax revenues, $\tau_t^y Y_t^M$. Given the path of government expenditure, expressed as a proportion of manufacturing output, the income tax adjusts to balance the budget every period according to,

$$g_t Y_t^M = \tau_{yt} Y_t^M + \tau_t C_t^{M*} P_t^{M*} + m_t \xi Y_t^M \tag{8}$$

As a result, the law of motion of public infrastructure, depreciating at the exponential rate δ_g, is given by,

$$\dot{K}_{gt} = g_t Y_t^M - \delta_g K_{gt} \tag{9}$$

Finally, private capital accumulates out of after tax output net of depreciation, δ_k, after allowing for domestic consumption, the purchase of foreign goods and the pure transfer associated with the Marshall Plan, according to the following law of motion,

$$\dot{K}_t = \left(1-\tau_{yt}\right) Y_t^M - C_t^M - \left(1+\tau_t\right) C_t^{M*} P_t^{M*} - \delta_k K_t + T_t \tag{10}$$

[6] 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 only in the hope to reduce the instability generated during the interwar years by private capital flows. Along these lines, Saint-Paul (1993) characterizes the French economy as "exchange controls prevailed, the market for foreign exchange was severely regulated and segmented with a complicated system of multiple exchange rates". Ben-David (1993) points out that "the EEC exhibited significantly increased trade, while exhibiting negligible improvements in factor flows".

3.4. Macroeconomic equilibrium

With the time path of labor allocation given by (4), our representative agent chooses consumption, both of domestic and foreign goods, to maximize the present value of her intertemporal utility given by (2), subject to (4) and (10). In her choices, the representative agent takes as given the paths of infrastructure, foreign aid and technology, ignoring the effects of her import choice on the path of technological change. The optimality conditions for this problem, where λ is the co-state variable associated with the private capital stock, are given by[7],

$$\frac{1}{C^M} = \lambda \tag{11.1}$$

$$\frac{\gamma}{C^{M*}} = \lambda\left(1+\tau_t\right)P^{M*} \tag{11.2}$$

$$\left(1-\tau_{yt}\right)\alpha\frac{Y^M}{K} - \delta_k = \rho - \hat{\lambda} \tag{11.3}$$

together with the household instantaneous budget constraint, (10), the law of motion of public capital, (9), and the transversality condition, $\lim_{t\to\infty}\lambda K e^{-\rho t} = 0$. Equations (11.1) and (11.2) guarantee the optimal allocation of income between domestic goods, foreign good and saving. Equation (11.3) is an intertemporal allocation condition that equates the rate of return on capital to the rate of return on consumption.

In the context of our historical episode, it seems sensible to make a further assumption, namely that the level of technology of the founding members of the Common Market was similar, $E_t^M = E_t^{M*}$. Since the intra-European trade balance of the average country in our sample is zero, $C_t^X = C_t^{M*}P_t^{M*}$, we reach the following law of motion for the efficiency of labor in the manufacturing sector,

$$\hat{E}^M = x_M\left(\eta\frac{2\gamma C^M}{\left(1+\tau_t\right)Y^M} + 1\right) \tag{12}$$

[7] Throughout the analysis, time subscripts are omitted when unambiguous.

We define a balanced growth path as being one along which all variables grow at constant rates. With capital being accumulated from manufacturing output, the only balanced solution is one in which the capital-output ratio in the manufacturing sector is constant. Following this definition it is convenient to define stationary variables of the form, $x_t \equiv X_t \Big/ \left(E_t^M\right)^{\frac{1-\alpha}{1-\alpha-\beta}}$. We use these variables to rewrite equations (9), (10) and (11.3) as follows,

$$\frac{\dot{c}^M}{c^M} = \left(1 - g_t + m_t\xi + \frac{\tau_t}{1+\tau_t}\gamma\frac{c^M}{y^M}\right)\alpha\frac{y^M}{k} - \delta_k - \rho - \left(\frac{1-\alpha}{1-\alpha-\beta}\right)\hat{E}^M \tag{13.1}$$

$$\dot{k}_g = g_t y^M - \delta_g k_g - \left(\frac{1-\alpha}{1-\alpha-\beta}\right)\hat{E}^M \tag{13.2}$$

$$\dot{k} = \left(1 - g_t + m_t\right)y^M - \frac{\left(1+\tau_t+\gamma\right)}{\left(1+\tau_t\right)}c^M - \delta_k k - \left(\frac{1-\alpha}{1-\alpha-\beta}\right)\hat{E}^M \tag{13.3}$$

where $y^M = k^\alpha\left(N^M\right)^{1-\alpha}k_g^\beta$, $\hat{E}^M$ is given by (12) and the evolution of N^M is given by (4).

Given initial conditions for private capital, public infrastructure, labor allocation and the level of efficiency of labor, the previous system uniquely determines the optimal paths for consumption and capital. Assuming constant paths for government expenditure, $g_t = \overline{g}$, foreign aid, $m_t = \overline{m}$, and tariffs, $\tau_t = \overline{\tau}$ we can solve (13) for the steady-state values of our endogenous variables setting $\dot{c} = \dot{k} = \dot{k}_g = \dot{N}^M = 0$.

4. Numerical Analysis of the European Golden Age

4.1 Calibration

We calibrate our model to reproduce some of the steady state features of our sample of economies. Table 1 summarizes the parameter values upon which our simulations are based. Our base period is one year. The rate of time preference, $\rho = 0.04$, and the rate of depreciation of physical capital, $\delta_k = 0.05$, are the standard values used in the Real Business Cycle literature; see Cooley and Prescott (1995). The elasticity of output to private capital, $\alpha = 0.34$, is consistent with the evidence presented by Gollin (2002). Following Turnovsky (2004) we set the rate of depreciation of public infrastructures, $\delta_g = 0.035$, and the elasticity of output to this input, $\beta = 0.2$. These estimates lie within the range of consensus estimates; see Gramlich (1994). The relative weight of intra-European imports in preferences, $\gamma = 0.164$, is chosen to match the average degree of intra-European trade during the 1970s, when barriers to trade were no longer present. Postan (1967) reports a 10-year increase in agricultural productivity of 73% for France, 67% for Germany, and 18% for the Netherlands during the 1950s. We set the rate of technological change in the agricultural sector, $x_A = 0.04$, equal to the average of these estimates. The rate of exogenous technological change in the manufacturing sector, $x_M = 0.014$, and the parameter that governs the effects of trade on technological change, $\eta = 0.034$, are chosen to match two facts: the average growth rate of our sample of economies over the past century[8] and the effects of trade on growth as captured by Frankel and Romer (1999). Their estimate suggests that a one percentage point increase in the degree of openness is associated with half a percentage point increase in the level of income per capita. Finally, consistent with the evidence presented by DeLong and Eichengreen (1991), we set $\xi = 0.15$, to tie one seventh of the Marshall aid to the provision of public infrastructure.

Along the stable growth path associated with the initial level of tariffs, this parameter configuration yields a growth rate of labor productivity in the manufacturing sector of 2.1%, a capital income share of 34%, an interest rate of 8%, a saving rate of 22% and a capital-output ratio of 2.7. All of these values are consistent with the patterns observed in modern industrial economies.

4.2 The Numerical Experiment

We follow a computational strategy similar to Chen et al. (2006). We set the initial values for the private capital stock, the stock of infrastructure and labor allocation equal to the average values for our sample of economies in 1948. Starting from this point, we use a forward shooting algorithm to solve for the equilibrium transitional path

[8] Maddison (2001) reports the following average growth rates of per capita real output for the twentieth century; Belgium, 1.7%, France, 2.0%, Germany, 1.9%, Italy 2.3% and Netherlands, 1.8%.

generated by our model economy as it converges to its steady state[9]. Our solution consists of two phases. In Phase I (1948-1956), our model economy moves towards the steady state that would have prevailed if the Common Market never occurred. In Phase II (1957-1980), starting from the levels of capital, infrastructure, labor allocation and technology generated by Phase I for 1957, our model economy moves towards the steady state associated with $\tau_t = 0$. Our representative agent learns in 1957 the complete path of tariffs induced by the Common Market and at that point adjusts her choices accordingly[10].

In our numerical exercise we use the actual time series of non-military government expenditure, g_t, Marshall aid, m_t, and intra-European tariffs, τ_t, from 1948 to 1973. Beginning in 1974, we set these exogenous variables equal to their long run values; $m_t = \tau_t = 0$ and $g_t = \bar{g}$, equal to its sample average. Data sources and descriptions are provided in the Appendix. The initial fraction of labor in agriculture, $N_{1948}^{A} = 0.3$, is set equal to the average value in our sample for 1948. The initial share of agricultural output on total production in the data is used to pin down $\bar{A} = .2Y_{1948}^{M}$. Finally, in line with evidence discussed by Alvarez-Cuadrado (2008), we set the initial stocks of private and public capital equal to 50% of its steady state levels in Phase I, calculated under the assumption that the sectoral labor allocation remains constant at the 1948 level.

Figure 1 reproduces the adjustment path of key economic variables. With the initial capital stock substantially below its steady state level, and a large share of the labor force still employed in the agricultural sector, the initial years of the transition are characterized by high and slowly decreasing growth. Three forces contribute to the initial growth of income per capita: the process of capital deepening associated with the reconstruction, the high level of public investment associated with the Marshall Plan and the continuous increase in manufacturing employment associated with structural change.

Along the transitional path, as capital accumulates, its marginal product falls, and the capital-output ratio increases. This reduction in the incentives for savings induces

[9] For a detailed explanation of forward-shooting algorithms see Judd (1998).

[10] For the computation of the two steady states we set $m_t = \bar{m} = 0$ and the share of government expenditure, $g_t = \bar{g}$, equal to its sample average.

continuous increases in consumption. The phase diagram reproduces this process of capital accumulation and increasing consumption. In 1957, the Treaty of Rome is signed, although the actual decrease in tariffs will not begin until 1959. This anticipated decrease in tariffs, which is equivalent to an anticipated decrease in the future price of consumption, leads to an immediate decrease in consumption. The new steady state, characterized by higher intra-European trade and faster technological diffusion, is associated with a lower level of capital per unit of effective labor so consumption grows at a faster pace than before, mainly through a substantial increase in imports. As the rate of technological change in the manufacturing sector increases, the rate of capital accumulation decreases as in the standard Solow model. After 1968, the level of intra-European trade is already close to its steady state value and the faster technological progress associated with it replaces capital accumulation and structural change as the main engine of growth.

The behavior of the saving rate is more erratic. In a standard one sector neoclassical model with Cobb-Douglas technology, a large destruction of capital induces an instantaneous increase in saving that thereafter monotonically converges to its unchanged steady state level. In our model economy, the initial increase in saving associated with the war is offset by the low savings levels characteristic of societies with large shares of labor in agriculture. During the first years of the transition, two effects govern the evolution of savings; on the one hand as capital accumulates, the saving rate falls, on the other hand as the share of labor in the manufacturing sector increases, so does savings. Throughout the first decade of the Golden Age, these effects cancel out and the saving rate follows a trend-less path. During the 1960s, the higher rate of technological change, resulting from the European integration, induces a decrease in savings that after 1968 converges from below to its new steady state value.

4.3 Sources of growth during the Golden Age: A quantitative assessment

Figure 2 compares the time series generated by our model with its data counterparts. Our model captures very well the path of sectoral labor migrations and the evolution of the share of agricultural production in total output. Given the tariff reductions imposed by the Treaty of Rome, the evolution of the degree of openness simulated by our model closely resembles the increases in intra-European trade that took place during the 1960s. Our main variable of interest is however the growth rate of output per capita. The last panel of Figure 2 suggests that our specification accounts for most of the growth during the Golden Age. The correlation coefficient between actual and simulated data is close to 0.93. Our model captures not only the trend, but also a substantial amount of the variation on growth during this period. The correlation coefficient between the de-trended actual growth rate and the de-trended model growth rate is 0.4. Furthermore, it is important to notice that our results are obtained in the absence of exogenous productivity shocks. These shocks are the source of much controversy in the literature and we find more appealing a set of results that abstracts from their influence. As an additional robustness check we follow the advice of King and Rebelo (1993) who warn against the counterfactual implications for the real interest rate of technologies that exhibit strong diminishing returns to capital[11]. In our experiments, despite the neoclassical technology and the large steady state gap considered, the interest rate never exceeds 20% in the initial periods of the transition. Moreover, this figure is consistent with the available evidence for our sample of countries. Saint-Paul (1993) uses national accounts data and estimates the rate of return to capital to be between 25% and 15% for France in the decade that followed the conflict. Dimson et al. (2002) report the ex post total return to equities to be 25% for Germany, 17% for France and 20% for Italy in the 1950s.

Overall, it is remarkable that such a stylized model captures so well the key features of the data. Not only does this reassure us about the choice of specification, parameter values and the relevance of the shocks examined, but it also builds our confidence for the growth decomposition exercise that follows.

We use our framework to conduct a series of counter-factual experiments in which we shut down, one at a time, the alternative sources of growth under consideration. We measure the relative contribution of a specific factor as the difference between the

[11] Under the assumption that after-war Japan and the U.S. had access to similar levels of technology and that the U.S. economy was in steady state, King and Rebelo (1993) evaluate the implications of a neoclassical growth model for the real interest rate. In the presence of diminishing returns to capital the Japanese steady state gap after the war is associated with a real interest rate implausibly high, in the order of 500%.

path of the growth rate in the complete model and the growth rate in the same model when that factor is absent. For instance, we calculate the relative contribution of structural change as the difference between the growth rate in our complete model and the growth rate in a model that, with the same initial conditions and shocks, imposes that the labor allocation across sectors remains constant at the 1948 level. We label this contribution as "Migrations".

Figure 3 summarizes our results. The first panel decomposes the actual growth rate into the contribution of each factor, while the second panel reports the relative contribution of each factor as a percentage of the actual growth rate. During the decade that followed the war, the reconstruction process and structural change explain almost 50% of the actual growth. On average, between 1948 and 1960, the transitional dynamics associated with the destruction of capital account for almost 1.75 percentage points of growth, while labor migration explains slightly more than 1 percentage point. In the following decade, the contribution of the reconstruction effort falls below 0.75 percentage points but, with almost 20% of the labor force in agriculture in 1960, there is still scope for substantial reallocation of resources. As a result, the contribution of labor migrations to growth remains as high as 1 percentage point during the 1960s. At the end of our period of interest, only 10% of the labor force remains in agriculture reducing substantially the potential gains from structural change. Our estimate of reconstruction growth is consistent with previous work by Gilchrist and Williams (2004) and Alvarez-Cuadrado (2008). The first authors use a vintage capital model to evaluate the post-war experience of West Germany. Their results suggest that the destruction of capital contributed to roughly 1.5 percentage points of per year growth during the 1950s. It is interesting that, in terms of the growth rate, the implications of a vintage capital model are in line with our results. Alvarez-Cuadrado (2008) explores the effects of the war in a sample similar to ours. He finds that the reconstruction effort adds between 1.6 and 2.0 percentage points to growth during the decade that followed the war. Our results for the contribution of structural change are also in line with the previous estimates in the literature. Temin (2002), using cross country regression methods, reports that Germany's growth rate received a boost of 1.2 percentage points per year as a consequence of sectoral labor migration. Temple (2001) extends the standard growth accounting framework to measure the contribution of labor reallocations to total factor productivity growth. For the 1950s, his estimates of the impact on growth of labor reallocations are in the order of 0.6 percentage points for France, 0.65 for Germany and 0.75 for Italy.

Next, we turn to examine the direct impact of the Marshall Plan. By construction one seventh of the aid is tied to the provision of public infrastructure. The remaining of the aid is endogenously allocated, with one third being devoted to investment and two thirds to consumption. In line with these results, Eichengreen and Uzan (1991) report that out of each dollar of aid some 35 cents went into increased investment. While in place, our model suggests that the American aid program increased the growth rate of the stock of infrastructures by half of a percentage point[12]. The induced increase in the marginal product of private capital combined with the temporarily higher availability of resources increases the rate of accumulation of capital by roughly two thirds of a percentage point. Nonetheless the effect on output is very modest; the Plan contributes to no more than one fourth of a percentage point of additional growth per year between 1948 and 1951. These 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.

In the decade that followed its birth, the growth effects of the Common Market were surprisingly small. This is the result of two counteracting forces: the surge in intra-European trade increases the rate of technological change in the manufacturing sector, but this positive effect is partially offset by the lower rate of investment associated with the free trade steady state. During the 1960s, these forces balance each other resulting in a very limited contribution of trade to growth. Towards the end of the Golden Age, the Common Market contributes to one fourth of a percentage point to growth and a decade later, once our economy is close enough to its steady state, our model suggests that intra-European trade boosts the growth rate of the Union by half a percentage point. In line

[12] 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 equals the production elasticity of the public input. Under our parameter values and given the observed path of government expenditure, the tied portion of the Marshall plan moves temporarily the level of public government expenditure closer to its optimal level.

with our results, DeLong (1991) suggests that the Common Market increased the growth rate between one half and one third of a percentage point in the mid-seventies for the member countries. Baldwin (1989), after accounting for the dynamic effects of trade, reports that the Common Market could add from one quarter to a full percentage point to the growth of the European Union.

5. Concluding Remarks

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 a two sector neoclassical growth model to quantify the contributions of the most relevant hypotheses presented in this literature.

Using actual data on Marshall Aid, government investment, tariffs and initial share of labor in agriculture, we simulate our model and explore its transitional dynamics after a large destruction of capital. The dynamic adjustment of our model resembles closely the actual time series for our sample of economies. Our results highlight the importance of reconstruction growth and structural change during the 1950s. Almost three percentage points of growth can be attributed to the combined effect of these two factors. During the 1960s, the contribution of reconstruction growth falls below half a percentage point, while migrations still contribute to one percentage point of additional per capita growth. The direct contribution of the Marshall Plan is limited in time and scope; as Milward (1984) hypothesized our model suggests that in the absence of the Plan, the post-war European growth record would not have been very different. Finally, our results highlight the increasing importance of the dynamic effects of trade that are only felt well into the 1970s. In the decade that followed its birth, the Common Market only increased the growth rate of its founding members somewhere between one eight and one forth of a percentage point over.

Furthermore, our results might provide valuable insights on the substantial reduction in the growth rate of output during the seventies. As anticipated by Temin (2002) and Temple (2001), standard quantifications of the productivity slowdown that fail to account for the important role played by internal migrations and the war reconstruction might overstate its true dimension. We plan to explore this possibility in future research.

Finally, we believe that the use of fully fledged general equilibrium models provides a valuable complement to traditional narrative and econometric methods. This is especially true in contexts like ours, where narrative approaches might be inconclusive and standard econometric methods face substantial identification problems.

T**able 1.** Parameter Values

Preference Parameters	Value	Comments
ρ	0.04	Cooley and Prescott (1995). Steady state interest rate equal to 8%
γ	0.164	To match intra-European trade during the 1970s
Technology Parameters		
α	0.34	Capital income share. Gollin (2002)
β	0.20	Turnovsky (2004)
δ_k	0.05	Cooley and Prescott (1995)
δ_g	0.05	Turnovsky (2004)
x_A	0.04	Postan (1967), average productivity growth in agriculture for France, Germany and the Netherlands.
x_M	0.014	Maddison (2001), average growth rate in our sample and effects of trade on growth summarized by Frankel and Romer's (1999) estimates.
η	0.034	
ξ	0.15	DeLong and Eichengreen (1991)

Figure 1. Dynamic adjustment of key economic variables.

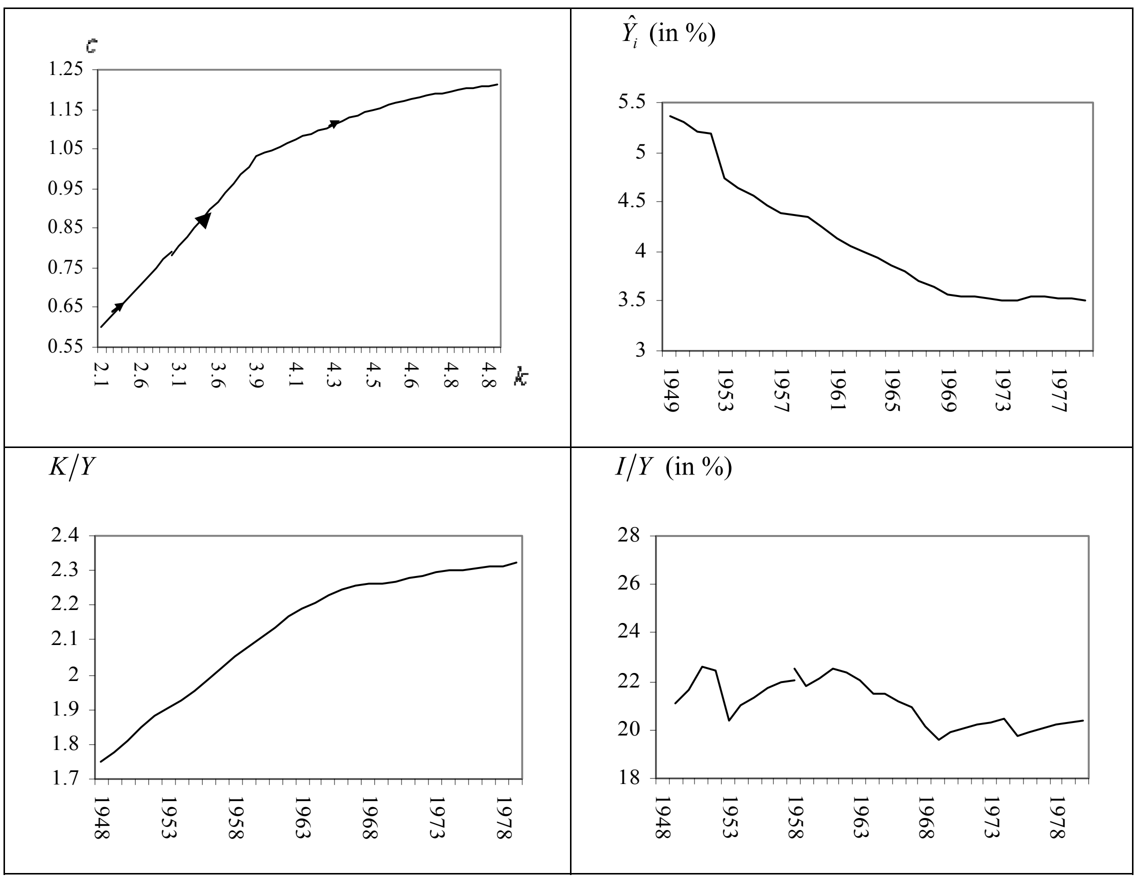


Figure 2. The European Golden Age: Model vs. Data (in percentage points).

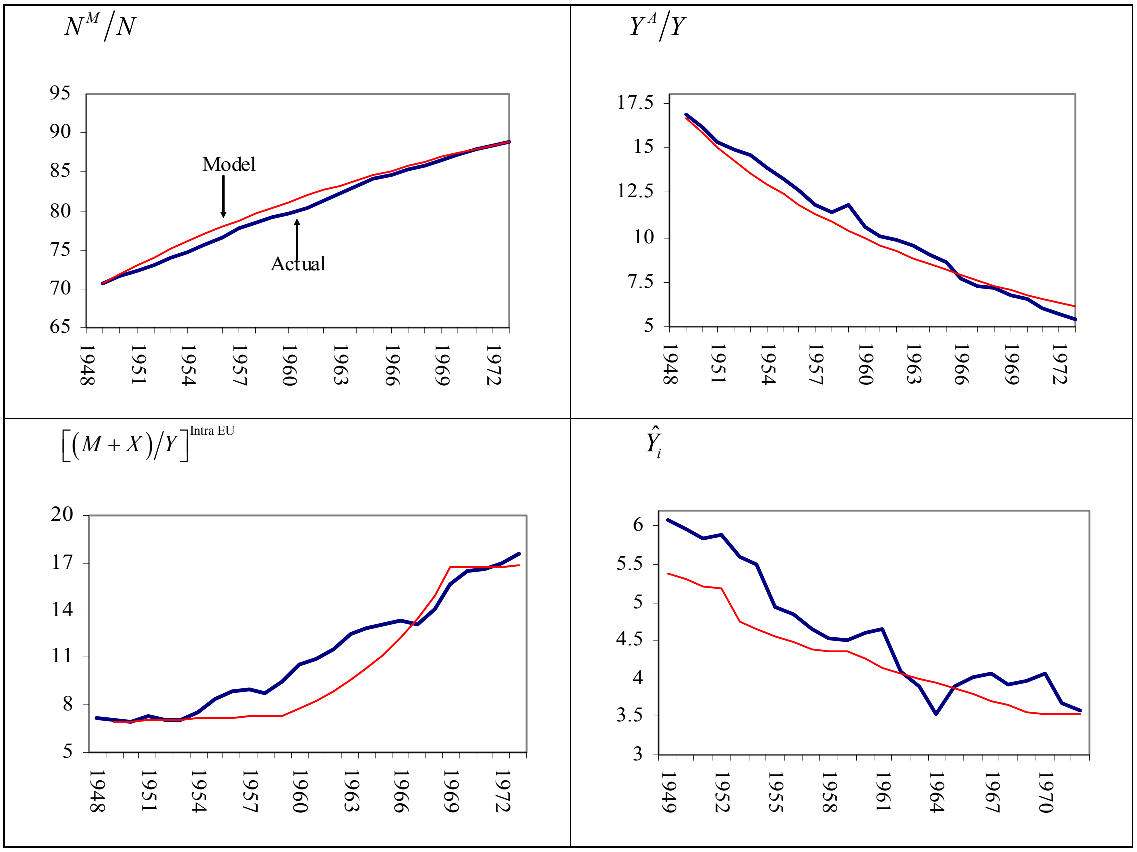
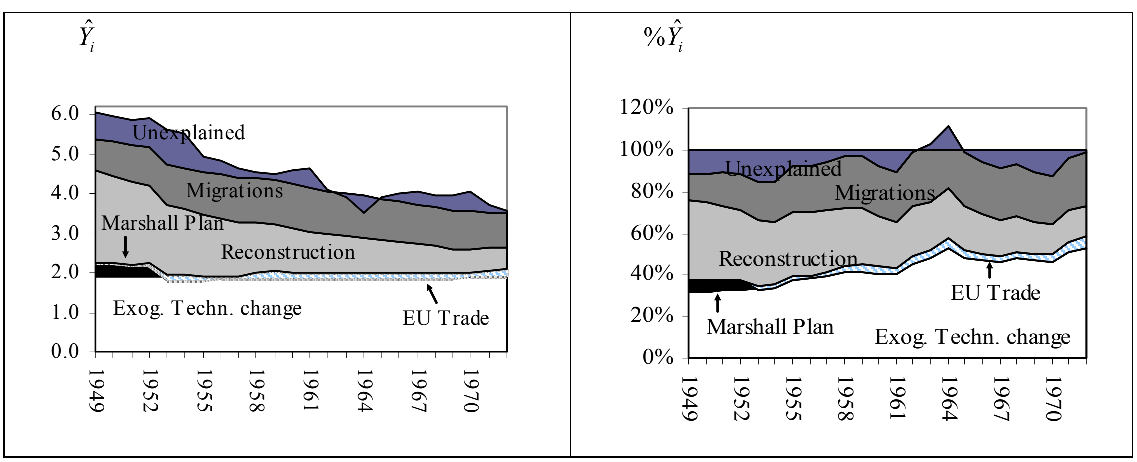


Figure 3. Sources of growth during the European Golden Age.



Appendix: Data Sources

Data on growth rates of income per capita income are from Alvarez-Cuadrado (2008). Our calculations are based on five-year moving averages.

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*).

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: 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*)). Data on trade is from Ben-David (1993).

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