Investment-led Growth in Crisis: The Finnish Great Depression Revisited

Tero Kuusi[54]

Abstract

This paper considers the collapse of the Finnish investment-led growth policy as a contributing factor to the Finnish Great Depression in the early 1990s. The policy change is analyzed with a dynamic general equilibrium model as a lifting of an investment-tax credit. The paper finds that the constructed policy change helps the model to replicate the depth and the persistence of the Finnish crisis in terms of a fall in employment, output, and investment. A reasonably sized financial crisis alone cannot explain the contraction and largely fails to account for the following long slump.

Keywords: business cycles, depression, transition, industrial policy JEL classification: E32, F41, P2

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1 Introduction

The Finnish Great Depression of the early 1990s (one of the worst economic crises in an industrial country since World War II) has received much attention in economic literature. An established view regarding the depression is that both Finland and Sweden experienced very similar severe currency and banking crises resulting from financial liberalization, while the deeper contraction in Finland can be explained by the fact that the Finnish economy suffered more from the collapse of the Soviet Union. However, results of the recent paper by Gorodnichenko et al. (2012, 2009) show that neither the Soviet trade shock nor financial shock are fully consistent with the wide-spread and persistent nature of the crisis (Gorodnichenko et al., 2009, figure 5). Production and especially investments fell substantially in all sectors of the economy[55] and the economic contraction was very persistent, affecting the economy until the 2000s, while the Finnish export market recovered fairly rapidly. The findings suggest that other explanations may still be warranted to understand the anatomy of the crisis.

This paper considers the collapse of the Finnish investment-led growth policy as a contributing factor to the crisis. The policy had a marked effect on the Finnish economy both during and before the crisis (see Pohjola, 1996; Heikkinen and Kuusterä, 2001). In the decades after World War II a high rate of investments was administratively maintained with accommodative monetary policy, tight control of capital, and heavy state involvement in the private sector. As a consequence, the country's production capacity was large at the onset of the crisis, while the marginal product of capital was low. The inefficiency problem escalated during the depression and the country faced a long-lasting restructuring of production. During the crisis the country's investment rate fell permanently to the rates of the US and Sweden.[56]

The policy change is analyzed with a dynamic general equilibrium model as a lifting of investment tax credit. The modeling choice is reasonable given that

[55] Aggregate production fell roughly 20 percent compared to the long-run trend, while for investments the contraction was almost 40 percent.

[56] The policy change was a unique feature of the Finnish crisis while in most other European countries, including Sweden, a similar transformation (albeit on a more modest scale) was already experienced in the 1970s. In Finland the investment rate was on average over 25 percent before the crisis, while during the crisis it permanently fell roughly 5 percentage points.

the main function of the policy (which consisted of a complex system of state regulation) was to lower the price of investment. Indeed, the next section shows how the crisis coincided with a permanent increase in the price of investments relative to consumption. This paper finds that the constructed policy change helps the model to replicate the depth and the persistence of the Finnish crisis in terms of a fall in employment, output, and investment. A reasonably sized financial crisis alone cannot explain the contraction and largely fails to account for the following long slump. Furthermore, the paper finds that the contribution of the overcapacity problem corresponds roughly to the difference in the depth of the Finnish and Swedish crises.

Key features of the model are taken from the recent paper by Hall (2011). It builds on the Keynesian notion that during a crisis the real interest rate is above its market-clearing level and consequently the supply of current output exceeds demand. The collapse of the growth model, as well as the financial crisis, had a strong lowering effect on final demand, and thus the market-clearing real interest rate was low. The higher price of investments decreased investment spending and the real interest rate should have fallen in order to generate other forms of demand.

However, it appears that the real interest rate was not responsive to the slackness. In the liberalized financial markets the world real interest rates was exogenous, while the room for public policies to manipulate interest and exchange rates, and provide fiscal easing was limited by the financial crisis. Furthermore, the Finnish experience contrasts with the dynamics in a standard Walrasian model where firms respond to sudden demand shocks by lowering prices. In the standard model this generates inflation expectations, which lowers the real interest rate and returns equilibrium in goods markets. Rather than assuming price adjustments, a key feature of the current model is that inflation does not respond to slackness in product markets. To support the assumption, this paper reports evidence from Finnish industry-level prices showing that they were irresponsive to contraction in output.[57].

Instead of adjusting prices, firms are assumed to respond to falling demand conditions by adjusting the utilization rate of capital. When the utilization rate

[57] Furthermore, the findings reflect well with those reported by Hall (2011) during the current US crisis..

falls, fewer workers are needed in production and unemployment emerges. In the model wages do not respond to lowering of the surplus that workers can provide in firms during downturns. As a result, demand for labor is procyclical. A reduced-form search model based on Hall's (2009) paper is used where the surplus depends on the slack in the use of capital, generating a tight relationship between the capital utilization rate and unemployment. Here the model also responds to downward wage rigidity during the depression, of which there is substantial evidence (see, e.g., Gorodnichenko et al., 2012).

When the price of installed capital starts to increase as a response to the policy change, the marginal product of capital must also increase in order to maintain the required return on investments. Consequently the capital stock starts to decline. However, increasing the marginal return on capital is costly, which forces the capital stock to react slowly to the overcapacity problem and the economy faces a long period of slackness.

To model the liberalized financial market, saving behavior is assumed to be governed by an exogenous return on investments in foreign assets. Households are the sole investors in the model and can invest in domestic and foreign bonds, as well as in capital and durable goods. Return on foreign assets becomes a binding constraint for domestic return on capital when assets can be traded across countries. However, domestic conditions are allowed to affect the household behavior. The consumption based real interest rate is partly affected by the changing price of domestic durable goods. Furthermore, during the financial crisis a fraction of households become credit constrained and are forced to save. Frictions in the financial markets affect investments in durable and capital goods, and are modeled as property taxes on holding the assets.

Similarly to Hall's (2011) work this paper focuses on the economic impact of the adverse forces during the recovery period. They consist of a combination of initial conditions and shocks which are calibrated to match the economic conditions at the end of 1993 and thereafter. As is common in the Great Depression literature, a perfect foresight model is considered where consumption's intertemporal elasticity of substitution governs behavior under uncertainty. Hall (2011) argues that a perfect foresight model gives a surprisingly good account of what happens in a dynamic model once a major surprise becomes known.

Investment tax credit governs the initial conditions of the simulation. It is calibrated based on the deviation of the actual capital stock from its subsequent growth path after the crisis. Using this measure, the total level shift in the capital stock series between the 1980s and the 2000s appears to be over 20 percent, while at the end of 1993 the remaining overcapacity is roughly 10 percent. Accordingly, the excess capacity is generated by initiating the simulations from a steady state that predicts a 10 percent decline in capital stock during the recovery period. Such transition is captured by starting simulations from a steady state with 7.5 percent investment tax credit while the tax credit is removed from the first period of the simulation.[58]

The financial crisis is modeled by solving the model as if the realization of financial shocks had just entered the initial steady state.[59] The first shock is captured by forcing 20 percent of the households to save an amount corresponding to 6.7 percent of GDP. Second, there is a two percent property tax on capital and durable goods. The financial conditions decay at a 10 percent quarterly rate and disappear by 1997. Finally, inflation remains constant at its steady state level, reflecting the central bank's inflation target, and the fiscal policy remains unresponsive to slackness.

In addition to its main results, the paper also shows that without the constrained real interest rate the economy can deal with the overcapacity problem while maintaining full employment by adjusting the domestic price level. The adjustment includes a rapid depreciation of the domestic price level followed by a slow recovery of the prices. A falling domestic price increases the share of domestic goods in final demand, while the recovery stimulates demand by increasing the expected real interest rate. While the Finnish Markka depreciated during the crisis, the observed adjustment of the capital stock is a clear indication that the overcapacity problem remained. The analysis indicates that the Finnish real exchange rate should have decreased by roughly 10 percent more than the Swedish

[58] It is noticeable that several other factors are omitted from the analysis, which include the Soviet fall and the multi-factor productivity (MFP) growth revival after the crisis. While abstracting them may hide the real size of the problem, focusing on the observed transition of the capital in a simplified model stock still gives a fairly good account of the size of the overcapacity problems given these features.

[59] That is, the shocks do not have an effect on the initial steady state which is used to benchmark the economic contraction.

real exchange rate given that only Finland had the overcapacity problem and the financial crisis was similar in both countries. However, the actual depreciations of the currencies were very similar in the two countries. In any case, it is questionable whether such real depreciation would even have been feasible.

This paper relates to several other papers. First, this paper complements the view that the fall of Soviet trade was an important factor in the crisis, as Gorodnichenko et al. (2012) argue. However, it proposes a different channel instead of the trade shock. Soviet trade helped to maintain the growth policy until the 1980s, while its collapse generated a far greater and more persistent shock than the trade shock alone could have produced. The current model can generate a permanent and widespread fall in output, employment, and fixed capital investments, as well as explain change in the relative price of investment without resorting to rather strong assumptions regarding sectorial labor movement, substitutability of energy, and consumption – as made by Gorodnichenko et al. (2012).

The paper is also closely related to Conesa et al. (2007). The authors find that the Finnish crisis was mostly driven by multi-factor productivity (MFP) shock, which, however, their real business cycle model cannot easily explain. This paper proposes that the shock can be explained as the unmeasured lowering of the utilization rate of capital. Conesa et al. (2007) also argue that tightened fiscal policy during the crisis could be a partial explanation. This explanation is not discussed here, as evidence of a significant tightening of fiscal policy is not apparent in the data (Gorodnichenko et al., 2012).

Evidence of the real impacts of financial constraints during the crisis is ample. Honkapohja et al. (2009) discusses thoroughly their effect on both firm and household behavior. This paper quantifies their importance while not attempting to capture the underlying financial accelerator mechanism. Recently, Freystätter (2011) studied the Finnish crisis with a DSGE model based on the framework of Gerthler et al. (2007). Compared to Gorodnichenko et al. (2012), Freystätter (2011) shows that the model captures the effects and the magnitude of the collapse of Soviet trade more accurately by modeling it as a capital obsolescence shock and combining this shock with balance sheet constrained firms. In this paper the financial frictions are taken into account in a more reduced form, while the focus is on replacing the capital obsolescence shock with an alternative description of the factors affecting investments.

An extensive description of the overcapacity problem in Finland can be found in the work of Pohjola (1996). Landesmann (1992) discusses the Swedish experience in the 1970s. Discussions of the policy change in other European countries can be found in Eichengreen (2007). Recently, Karanassou et al. (2008) suggest that capital accumulation plays a fundamental role in shaping unemployment movements in Sweden and Finland and is related to the literature on the inverse relationship between the investment rate and unemployment. While the current paper agrees with their conclusion that the relationship follows from too few investments, the explanation based on overcapacity problem is more explicit.

This paper focuses on the overcapacity problem during the crisis, but it should be stressed that in the long run the policy change led to productivity enhancing structural transformations in the country. For example, Maliranta et al. (2009) show how the beginning of financial liberalization and deregulation in the mid-1980s coincided with a period of rapid productivity improvements and creative destruction. An illustrative framework to understand the long-run effects of the liberalization and the change in the technological paradigm is given by Acemoglu et al. (2006).

The paper is organized as follows. Section 2 discusses the economic environment and collects empirical facts on the crisis. Section 3 describes the model. In Section 4, calibration of the model is discussed. Section 5 reports quantitative results of the benchmark simulations. Section 6 discusses alternative specifications, while section 7 concludes.

2 The Economic Environment: Empirical Evidence

This section outlines the empirical evidence regarding the economic conditions during the crisis and the recovery period. The first subsection discusses the collapse of the investment-led growth policy. The second subsection considers other reasons for the crisis. The last subsection discusses economic policies during the crisis period. This section abstracts the discussion of the fall of Soviet trade that is extensively analyzed by Gorodnichenko et al. (2012).

2.1 The Investment-led Growth Model

Finnish monetary and fiscal policies fostered economic growth by channeling resources towards industrialization in the decades after World War the II (see, e.g., Korkman, 1992; Pohjola, 1996; Heikkinen and Kuusterä, 2001). There was an implicit understanding between industry and the central bank that low and stable interest rates, as well as fixed exchange rates, should be maintained in order to ensure a supportive and stable investment environment. At the same time capital flows were tightly regulated and interest rates were set administratively below the market-clearing levels. While the exchange rate regime was fixed, large adjustments were made if that was necessary to ensure some minimum return on investment. Before the Finnish Great Depression of the early 1990s, sizable devaluations of the Finnish Markka were undertaken in 1949, 1957, 1967, 1977–1978 and 1982. Finally, the government intervened in the market by setting-up state-owned enterprises and by granting subsidies.

Many European countries resorted to similar policies after World War II. However, in most other countries the period of rapid catch-up ended with the oil crisis of the 1970s. In Sweden, for example, the 1970s was a time of major structural changes. Figure (6.2) shows how, after the investment boom in the early 1970s, the volume of investments in Sweden dropped substantially and the investment rate never returned to the old levels. Landesmann (1992) describes the period being difficult for the Swedish economy. Problems in the private sector forced the government to rescue ailing firms and support the restructuring of Swedish industry. However, by the early 1980s the restructuring proved to be successful and the Swedish economy gained a position as an exporter in high technology areas.

Unlike many other countries, Finland continued to rely on the extensive growth model until the late 1980s. This was partly because bilateral trade with the Soviet Union rescued the Finnish economy from a deeper recession in the 1970s. The rising oil price meant that Finland could export more industrial products to the Soviet Union due to the countries' bilateral barter trade agreement. Indeed, in the mid-1970s the Finnish economy experienced record high levels of investment

(Heikkinen and Kuusterä, 2001).

However, by the early 1980s Finnish officials became increasingly aware of the destabilizing effect of the system. Resorting to devaluation from time to time was an inevitable consequence of conducting economic policies that bring about a rate of inflation that is higher than in the rest of the world. The resulting inflation/devaluation cycle gradually became deeply rooted in expectations and made its removal difficult. Furthermore, several indicators suggest that the Finnish economy was suffering from an overcapacity problem. Pohjola (1996) analyzes aggregate, industry-level, and firm-level data and concludes that the capital-output ratio in the country was high, while return on investments was low in the late 1980s and the early 1990s.

Modernization and liberalization of the financial market became topical in the early 1980s. The financial markets opened gradually in cycles of deregulation that included the abolition of the regulation of domestic bank lending rates and, later, the lifting of restrictions on private borrowing from abroad (Honkapohja et al., 2009). By the mid 1980s most of the regulations were removed. The development had a marked impact on the Finnish growth strategy. Institutional means of maintaining the low real interest rates through independent monetary policy and circulating domestic savings back to investments were reduced substantially. Furthermore, major reforms of the tax system were gradually carried out during the years 1987 - 1993[60]. The statutory corporate income tax rate was very high before the reform (on average 50 per cent in 1987), but generous inventory and investment reserves (up to 20% of profits) considerably reduced the corporate taxes collected. After the reform the corporate tax rate was the same for both distributed and for retained earnings (28 percent from 1996). (Valkonen, 1999)

The effect of the policy change is clearly seen in the data. Figure (6.1) shows that the gap in the price of investment relative to consumption compared to the US disappeared permanently during the liberalization and the crisis period. The

[60] The motivations for the corporate and capital income tax reform were both external and internal. Domestically, the most compelling reasons were the need to improve the efficiency of the allocation of capital and to promote neutrality in taxation of industrial branches, types of capital, sources of financing and investing sectors. Also, opportunities for tax arbitrage had emerged as a result of the deregulation of credit markets. International pressures were generated by the deepening economic integration to other parts of Western Europe and the wave of tax reforms carried out there, which intensified tax competition. (for details, see Valkonen, 1999)

relative price reflects both the high cost of consumption in regulated economy and the measures to lower the cost of investments given that the item prices provided are final product prices including taxes and subsidies. It is noticeable that the relative price does not directly take into account the effect of low (or even negative) real interest rate in the decades before the crisis, and thus the relative price is likely to be a moderate proxy for the actual incentive to invest.

Figure (6.2) shows that while the Finnish investment share of GDP was significantly higher than in the US throughout the post World War II period, following the crisis the difference disappeared. It appears that the investment frenzy of the late 1980s maintained the high investment rate, while a permanent change was not seen before the early 1990s. Finally, Figures (6.3 and 4) show the estimates of Finnish non-residential and residential capital stocks based on the perpetual inventory method[61]. The former clearly indicates that the non-residential capital stock gradually declined towards a new, lower growth trajectory. It is interesting to notice that residential capital does not seem to have a major role in the structural change.

2.2 Other Factors Contributing to the Crisis

An extensive literature finds that the main factors contributing to the crisis were financial (see, e.g., Kalela et al., 2001; Jonung et al., 2008; Honkapohja et al., 2009). The financial crisis was preceded by an overheating, which resulted from poorly designed financial regulation. Due to the financial liberalization there was an explosion of domestic credit and capital inflows, a significant fraction denominated in foreign currency. Economic policies during the period were not sufficiently restrictive to counteract the boom. Furthermore, a sharp increase in the terms of trade resulted from a fall in energy prices and a rise in the world market prices of forest products that also contributed to the overheating.

The boom reached its peak in 1990 and rapid contraction of the economy began. The economic downturn was due to factors that can be classified as shocks and economic policy effects. The Finnish export market shrank significantly both because of slow growth in market economies and the collapse of a major trading

[61] Based on the calculations of Matti Pohjola.

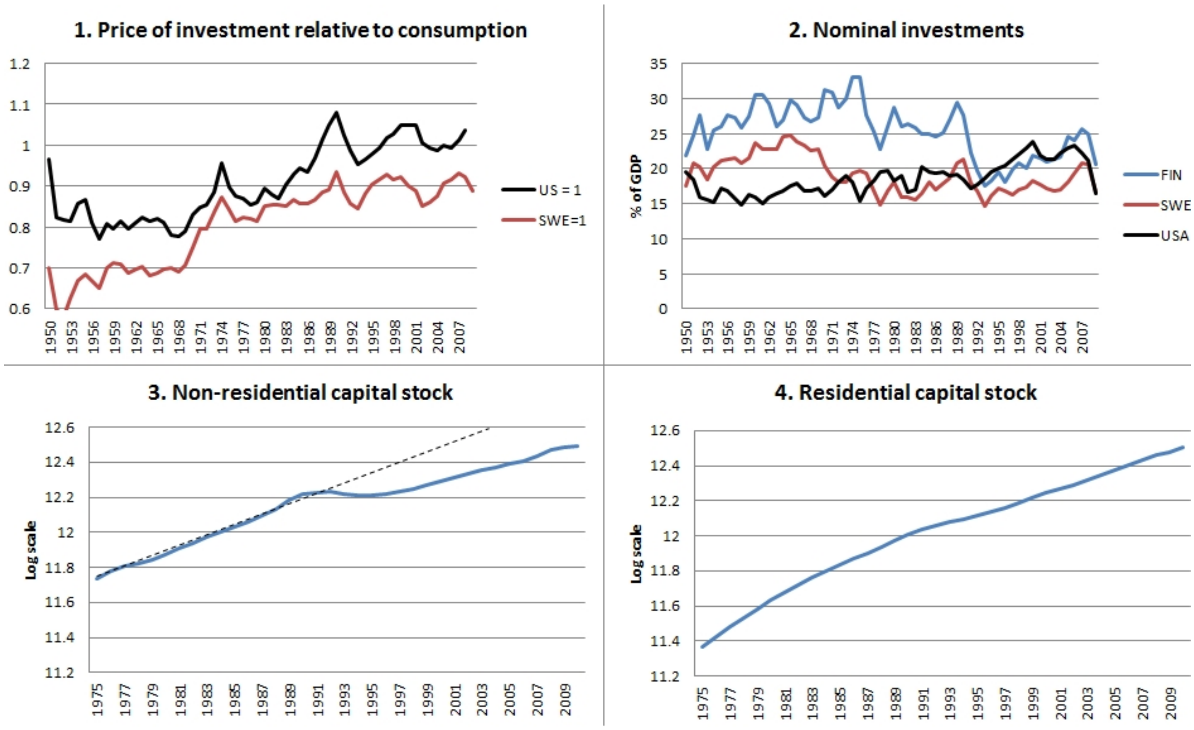


Figure 6: Investments

partner, the Soviet Union. However, the Soviet trade shock should not be exaggerated. In 1991 exports to the Soviet Union were around 15 percent of total exports, and the share of total exports in the GDP was 23 percent. After allowing for a multiplier, the 70 percent decline in this trade can account for three percentage points of the total decline of seven percent in 1991 (Honkapohja et al., 2009). At the same time, interest rates in Europe rose, reflecting the tightening of monetary policy after the German unification. Lastly, in defense of the fixed exchange rate, the Bank of Finland tightened monetary conditions in Finland significantly. As a result the interest rate increased even more and the Finnish Markka appreciated. The currency came later under a speculative attack that forced the central bank to leave the fixed currency regime and let the value of the Markka depreciate.

This paper follows Hall (2011) in considering various adverse economic conditions during a financial crisis. First, a large spread between lending and borrowing rates emerges, reflecting the agency relationship between investors and financial intermediates, as well as frictions in the banking system. Honkapohja et al. (2009), among others, show evidence that firms suffered from significant financial frictions caused by high leverage both in firms and in the financial system. The defense of the pegged exchange rate led to a period of high real interest rates that undermined the value of the assets of households and corporations, creating a process of falling asset prices.

Honkapohja et al. (2009) suggests that major signs of frictions disappear by 1997, at about the same time that the debt burden returns to a normal level. This paper calibrates the shocks to be equal to the ones used by Hall (2011) to describe the current US crisis, that is as equivalent to a two percent property and capital tax at the annual rate. The existing data on credit spreads presented in figure (7) suggests that the calibrated size is reasonable.

Second, the financial crisis generates a situation where a significant share of consumption is restricted by households' ability to borrow in the crisis period. Following Hall (2011), a household is considered credit constrained if its liquid assets (holdings in savings accounts and other liquid assets) minus the amount of outstanding consumption credit is less than two months income. Finnish consumer data suggests that in 1994 the income share of such households was roughly 20 percent of all household income. All income of the constrained households goes to consumption, which is restricted by their debt burden. Here, debt burden (s_t) is defined as interest payments and amortization minus the amount of new loans. The figure (7) shows the total household debt burden as a share of GDP in Finland 1975–2010. It indicates that the debt burden reached 6.7 percent of GDP in 1992 and only reached a normal level in 1997. Following Hall (2011) deleveraging is assumed to restrict the consumption of constrained households.

The frictions and the debt burden are taken to follow an autoregressive process with the rate of decay set at 0.9, and to disappear in 1997.

Finally, Hall (2011) considers the overhang of consumer durables and housing as a source of falling consumption demand during the current economic crisis. While in the current crisis this may play an important role, based on the figure (6.4) it seems that the housing capital stock in Finland did not significantly exceed its long-run growth path.

Honkapohja (2009) discusses fiscal policies during the recovery period and concludes that during the Finnish economic crisis fiscal policy was not consistently designed for stabilizing aggregate demand. It is true that during the crisis the GDP share of the public sector increased dramatically. However, the expenditure increased mainly as a result of increased transfers, especially unemployment compensation. The crisis was accompanied by a large increase in the central government debt and, from the mid 1990s, the government adopted a program of fiscal consolidation reflecting the requirements for membership in the EMU. According to Honkapohja et al. (2009), government support for banks and the effect of automatic stabilizers were counteracted by cuts in government expenditures and increases in tax rates. Gorodnichenko et al. (2012), contrary to Conesa et al. (2007), find no evidence of significant tax hikes during the crisis. Based on these findings this paper abstracts from the role of fiscal policy in the crisis.

2.3 The Near Exogeneity of Prices

This subsection discusses the determination of prices in the Finnish economy during the recovery period. Hall (2011) shows that assuming the given, unresponsive real interest rate achieves a crucial simplification of macro modeling while providing intuition regarding the roots of economic crises . Next, evidence is presented

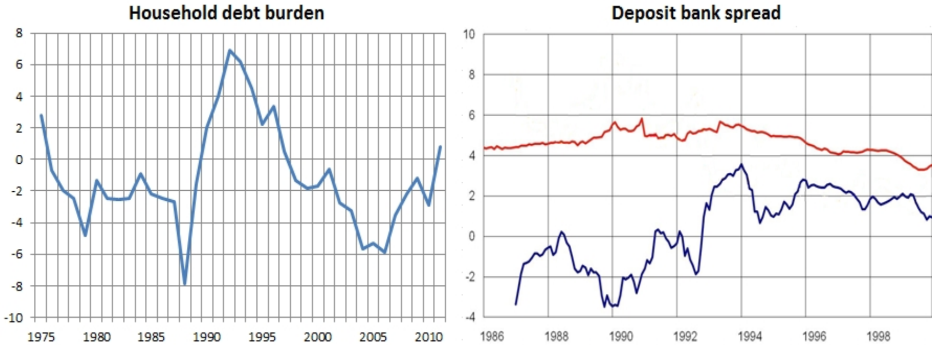


Figure 7: Debt burden as % of nom. GDP. Spreads: red = average loan rate - borrowing rate, blue = average loan rate - 12 mth Euribor

which suggests that considering the nominal interest rate and prices of tradable goods as exogenous is a reasonable approximation after 1993.

First, from 1993 onwards the central bank implemented a two percent inflation target that it maintained until 1999, when monetary independence ended and the country joined the euro. The level was chosen because it was considered to be more or less equal to the implicit or the explicit target announced by other countries aiming at price stability. As figure (8) shows, the policy succeeded in maintaining substantially smaller fluctuations in the nominal exchange, and the nominal interest rate followed the German nominal interest rate closely during most of the recovery period.

There was limited room for the Bank of Finland to adjust the nominal exchange rate during the recovery period. According to Honkapohja and Koskela (1999) defending the value of the currency to prevent an outflow of foreign capital would have required a raise in domestic interest rates, which would have hurt the highly indebted private sector. Improving the weakened competitiveness of the export sector would have required a devalued exchange rate, which would have hurt those who had borrowed abroad. In the end, either a tightening of monetary policy or a depreciation would lead to bankruptcies and rising unemployment. The central bank also feared that the pass-through of the nominal adjustments to factor prices was strong, and thus they would only generate higher domestic inflation without improving external competitiveness (Suvanto, 2000). Nevertheless, at the onset of the crisis the Bank of Finland abandoned the fixed exchange rate, first by devaluating the currency in November 1991 and then by floating the currency in September 1992. The size of the depreciation was comparable to the Swedish depreciation at the same time.

Second, a look on the Finnish data shows that the adjustment of relative prices was weak. Figure (8.2) shows how the Finnish real exchange rate follows the nominal exchange rate tightly, despite major slackness in the economy (unemployment only peaked in 1995). While it could be argued that they might be connected because of common shocks, the volatility of the real exchange rate is connected to changes in the monetary policy regime, which is a sign of real price rigidity. Furthermore, the Finnish industry level data suggests that industries did not respond to changing demand by adjusting prices. Rather, the firms adjusted their production by controlling capacity. Figure (8.3) reports a missing correlation between output change and price change in the Finnish manufacturing industries 1990–1994[62]. Figure (8.4) shows how there is a strong negative relationship between output changes and changes in the number of employed workers in Finnish manufacturing industries.

3 A Quantitative Model of the Finnish Crisis

This section introduces a general equilibrium model used in the quantitative exercise. In many key features the model corresponds with the Hall (2011) model . In particular, it illustrates how slackness may emerge, when the real interest rate is above its market clearing level. In contrast to a standard Walrasian model, prices do not settle the market, but rather the utilization rate of capital adjusts supply to meet the lowered demand. The main difference between the current model and Hall's (2011) is that in the current model a small open economy is considered.

Figure (9) outlines the model structure[63]. A representative firm operating in competitive markets produces a domestic good that is either exported or combined together with a foreign good into a domestic final good according to a CES aggre-

[62] Data for major manufacturing industries from EU KLEMS, 2009 edition. Hall (2011) makes a similar finding for US industries during the current economic crisis.

[63] A more detailed figure is found in the appendix.

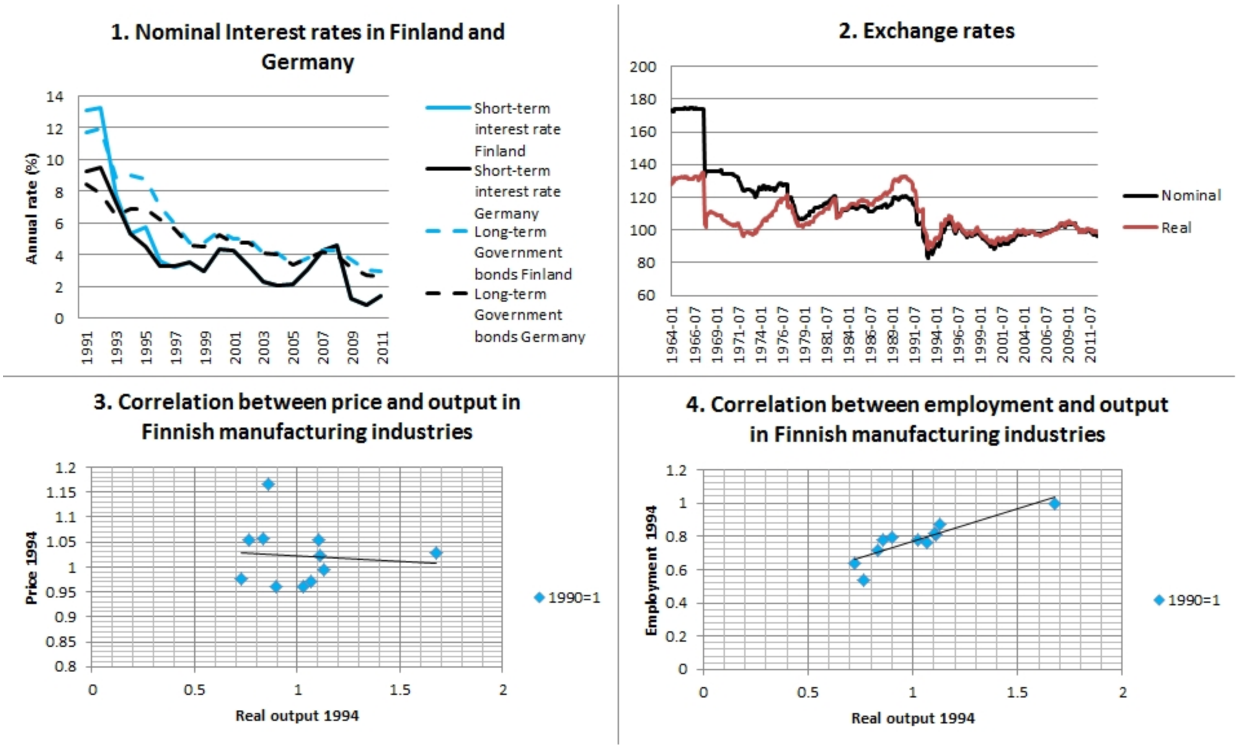


Figure 8: Price Rigidity

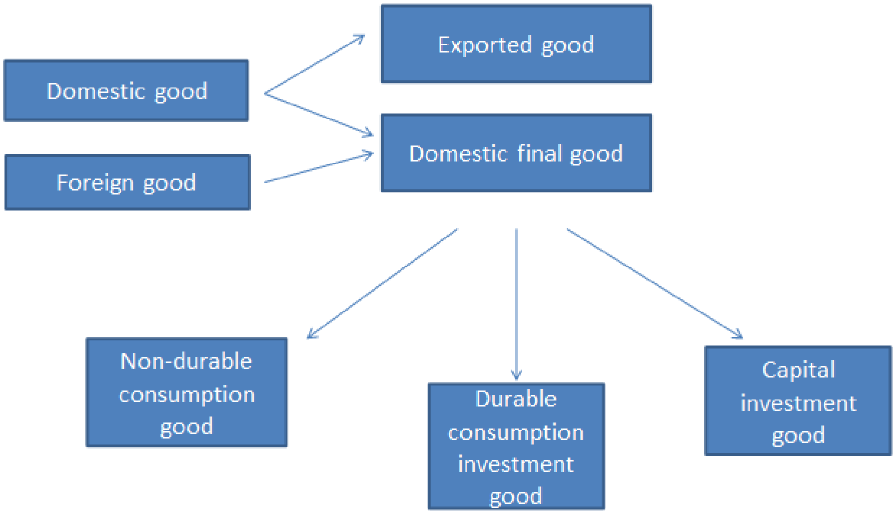


Figure 9: Model structure

gator. The domestic final good can be used as a non-durable consumption good, capital investment good, or durable consumption investment good. Final goods are fully substitutable and investment goods are transformed by capital producers into capital in the period following their creation.

In the model there are two types of households. A credit unconstrained household can invest in the capital goods or acquire bonds denominated in domestic or foreign currency. A constrained household does not have access to the financial markets. Both households provide labor and maximize intratemporal utility.

3.1 International Trade

Domestic and foreign goods are combined into domestic final good which is consumed or invested. The final good is a CES aggregate of domestic and foreign good, its price being

$$p_t = (p_{y,t}^{-\theta} + p_{w,t}^{-\theta})^{-\frac{1}{\theta}}$$

where θ is the elasticity of domestic and foreign goods in the production of the final good, p_y and p_w are domestic prices of the domestic and the foreign good, respectively. The cost share of the domestic good in the final product is also a function of relative prices.

$$\pi_t = \frac{p_y^{-\theta}}{p_w^{-\theta} + p_y^{-\theta}}$$

The size of the economy in the initial steady state is pinned down with an additional condition that governs the volume of the export market as a function of domestic and foreign prices:

$$ex_t = f(p_{y,t}, p_{w,t}).$$

Furthermore, trade is balanced[64].and the purchasing power parity (PPP) condition holds:

$$p^*_{y,t} = \xi \frac{p_{y,t}}{\epsilon_t} \tag{33}$$

where p^*_y is the price of the domestic good abroad, ξ is the cost of transportation and ϵ_t is the nominal exchange rate. The price p^*_y is given in the international commodity market.

3.2 Households

To model household behavior during the crisis, two types of households, constrained and unconstrained, are assumed. The unconstrained household engage in saving and consumes according to the optimal consumption path. It can invest in domestic and foreign bonds as well as in the two types of capital. International financial markets are assumed to be incomplete. The foreign bond is denominated in terms of tradable goods in foreign markets with the gross nominal rate of return

[64] The export condition is relaxed during the simulated transition, as prices are fixed and thus one less equation is needed to identify the equilibrium path. During the transition the balanced trade condition governs exports.

$(1 + r_t^{n,*})$ and the domestic bond in terms of the tradable good in the domestic market yielding the nominal return $(1 + r_t^n)$.

The constrained household is restricted from the financial markets and consumes all its income after payments for outstanding loans while maximizing utility with respect to the allocation of its intratemporal consumption.

A tilde $\widetilde{()}$ denotes unconstrained and a bar $\overline{()}$ constrained consumption. Consumption is a Cobb-Douglas composite of non-durable consumption, $c_{y,t}$, and the services of durables, d_{t-1}, constructed at the end of period t-1:

$$\overline{c}_t = \overline{c}_{y,t}^{\phi} \overline{d}_{t-1}^{1-\phi},$$

and consumption is calculated similarly for unconstrained households. The price of composite consumption is

$$p_{c,t} = \phi^{-\phi}(1-\phi)^{-(1-\phi)} p_t^{\phi} p_{d,t}^{1-\phi},$$

a combination of the price of nondurable goods (imported and domestic) and the rental cost of durables, $p_{d,t}$.The constrained household's demand for the nondurable goods component of consumption satisfies

$$p_t \overline{c}_{y,t} = \phi p_{c,t} \overline{c}_t$$

and demand is calculated similarly for the unconstrained household. Combining the two yields the total nondurable consumption as

$$p_t c_{y,t} = \phi p_{c,t} (\widetilde{c}_t + \overline{c}_t)$$

while total consumption of durable services is

$$p_{d,t} d_{t-1} = (1-\phi) p_{c,t} (\widetilde{c}_t + \overline{c}_t).$$

The unconstrained households choose their paths of composite consumption according to the intertemporal utility function

$$\sum_{t=0}^{\infty} \beta^t \frac{\widetilde{c}_t^{1-1/\sigma}}{1-1/\sigma},$$

where σ is the intertemporal elasticity of substitution. The unconstrained household price assets with returns measured in units of output by the discounter

$$\mu_t = \beta \frac{p_{c,t}}{p_{c,t+1}} \left(\frac{\tilde{c}_{t+1}}{\tilde{c}_t} \right)^{-\frac{1}{\sigma}}$$

In the optimum the consumption growth results in a discounter that discounts the market real interest rate to one:

$$1 + r_t^n = (1 + r_t^{n,*}) \frac{\epsilon_{t+1}}{\epsilon_t} = \frac{1}{\mu_t}.$$

Furthermore, a zero arbitrage condition holds for the return on investment in durable and capital goods:

$$\begin{aligned} (1 + r_{t-1}^n)(1 + f_{d,t}) &= \frac{p_{d,t} + (1 - \delta_k) q_{d,t}}{q_{d,t-1}}. \\ (1 + r_{t-1}^n)(1 + f_{k,t}) &= \frac{p_{k,t+1} + (1 - \delta_k) q_{d,t}}{q_{d,t-1}} \end{aligned}$$

where q_t is the price of a newly installed good at the end of period t. For one unit of output the household can buy $\frac{1}{q_{t-1}}$ units of the investment good in the end of the period t-1. Its value in t consists of the rental price in t and the amount at which the good sells at t. In equilibrium, carrying one unit over time must yield the required return on investment, which is due to the financial frictions (f), higher than the gross nominal interest rate.

Finally, constrained households' consumption is proportional to the size of the economy and depends on the financial constraint:

$$p_{c,t} \bar{c}_t = p_{y,t} (\omega y_t - s_t y_t)$$

where ω is the fraction of constrained households in total income and s_t is the burden of interest and debt payments of constrained households as a fraction of output.

3.3 Interest Rates and Prices

Consumer optimization suggests that the interest rate parity condition holds for the nominal interest rates:

$$1 + r_t^n = (1 + r_t^{n,*})\frac{\epsilon_{t+1}}{\epsilon_t},$$

where $1+r_t^n$ and $1+r_t^{n,*}$ are the domestic and foreign gross nominal interest rates, respectively. Domestic monetary policy is restricted to maintain a similar rate of inflation with other countries implying $\epsilon_t = \epsilon$ and thus $r_t^n = r_t^{n,*}$ consistently with the observed convergence of nominal interest rates with Germany. Furthermore, the international real interest rate, r_t is defined as the own rate of tradable goods in the foreign market which equals the domestic real interest rate (the own rate of domestic output in the domestic market) under the specified monetary policy:

$$1 + r_t^* \equiv (1 + r_t^{n,*})\frac{p_{y,t}^*}{p_{y,t+1}^*} = (1 + r_t^n)\frac{p_{y,t}}{p_{y,t+1}} \equiv 1 + r_t \tag{34}$$

The model abstracts from further analysis of money and the prices are determined in relative terms. The nominal interest rate is set to 0 in which case $1 + r_t = \frac{p_{y,t}^*}{p_{y,t+1}^*} = \frac{p_{f,t}}{p_{f,t+1}} = 1 + r_t^*$.

In the model prices are exogenous and their change corresponds with the rate of foreign inflation. In principle, economic slowdown could be expected to lower the rate of domestic inflation which generates the need to decrease the domestic nominal interest rate to maintain the targeted rate of inflation. However, sticky prices mean that the monetary policy does not generate such stimulation.[65]

3.4 Production

The domestic good is produced by a representative firm that chooses inputs to maximize its flow of profits:

[65] A choice is made here to remain agnostic over the exact source of price exogeneity. Instead of considering exogenous prices, wages could as well be considered fixed in which case prices would be solved from the model. At face value there is evidence of both forms of rigidity. However, the model simulations presented later on suggest that both price measures are consistent with their observed patterns, when prices are fixed. Thus, fixing wages would not change the results.

$$\max_{n,k} p_{y,t} y(x_t k_{t-1}, n_t) - w_t n_t - p_{k,t} k_{t-1}$$

where y denotes the production function, x_t is the capital utilization rate, w_t is the per worker wage, n_t is the number of workers, $p_{k,t}$ is the rental cost of capital, and k_{t-1} is the available capital constructed at the end of period t-1. While the firm can adjust its current utilization of capital, it expects to fully utilize newly acquired capital, that is $\frac{\partial}{\partial k_t} y_{t+1} = \frac{\partial}{\partial (x_t k_t)} y_{t+1}$. The first order conditions with respect to k_t and n_t are the usual:

$$\begin{aligned} w_t &= p_{y,t} \frac{\partial}{\partial n_t} y_t, \\ p_{k,t} &= p_{y,t} \frac{\partial}{\partial k_{t-1}} y_t \end{aligned}$$

Throughout the exercise Cobb-Douglas production function is assumed: $y_t = A n_t^{\alpha} (x_t k_{t-1})^{1-\alpha}$, where α is the nominal cost share of labor in production and A is MFP. Then,

$$\begin{aligned} w_t &= p_{y,t} A \alpha (\frac{x_t k_{t-1}}{n_t})^{1-\alpha} \\ p_{k,t} &= p_{y,t} A (1-\alpha) (\frac{x_t k_{t-1}}{n_t})^{-\alpha} \end{aligned}$$

3.5 Capital and Durable Good Producers

Capital and durable goods are produced by combining old capital and investment goods to produce new capital. The task of capital producers in the model is to help firms to use capital efficiently and to maintain the durable stock. They operate competitively and use domestic resources to adjust the size of the capital stock and the need for resources increases with the size of adjustment.

The aggregate capital stock evolves according to

$$\begin{aligned} k_t &= i_{k,t} + (1-\delta_k)k_{t-1} \\ d_t &= i_{d,t} + (1-\delta_d)d_{t-1} \end{aligned}$$

The producers optimization problem is to maximize profits, subject to a quadratic adjustment cost:

$$\begin{aligned} &\max_{i_{k,t}} q_{k,t} i_{k,t} - (1-\tau)p_t i_{k,t} - p_{y,t}\frac{\chi_k}{2}\frac{(k_t - k_{t-1})^2}{k_{t-1}} \\ &\max_{i_{d,t}} q_{d,t} i_{d,t} - p_t i_{d,t} - p_{y,t}\frac{\chi_d}{2}\frac{(d_t - d_{t-1})^2}{d_{t-1}}, \end{aligned}$$

where τ is the investment tax credit. Under zero profits the maximization problems yield the following first order condition for $i_{k,t}$ and $i_{d,t}$:

$$\begin{aligned} q_{k,t} &= p_t(1-\tau) + p_{y,t}\chi_k \frac{(k_t - k_{t-1})}{k_{t-1}} \\ q_{d,t} &= p_t + p_{y,t}\chi_d \frac{(d_t - d_{t-1})}{d_{t-1}} \end{aligned}$$

where q_k (q_d) is Tobin's q, i.e., the shadow price of installed capital (durable good).

3.6 Employment

Employment is modeled with a reduced form search model following Hall (2009, 2011). In the original RBC model (Kydland and Prescott, 1982) implausibly high Frisch wage elasticity is required during recessions to equalize the marginal rate of substitution between consumption and time spent working. To overcome this problem, in the standard Diamond-Mortensen-Pissarides model the condition arises from unemployment rather than from the hours of work of those employed; but recently Shimer (2010) shows that the standard model still fails to generate enough labor fluctuation.

Hall (2009) replaces Mortensen and Pissarides's Nash wage bargaining by a generalization that allows the share of employment surplus captured by employers to decline in recessions, resulting in less recruitment effort and higher unemployment.

All workers desire to work a standard number of hours. The only source of variation in aggregate hours arises from unemployment. Employers post vacancies to fill jobs. The probability of finding a worker to fill the vacancy is q. Filling the job becomes harder when the job market is tight, i.e. the vacancy/unemployment ratio, θ, is high. With the job-finding rate: $\phi(\theta)$ (increasing and concave function of θ), vacancy-filling rate: $\frac{\phi(\theta)}{\theta}$ and the exogenous job destruction rate s, the equilibrium employment rate is

$$1 - \frac{(\overline{n} - n)}{\overline{n}} = \frac{\phi(\theta)}{s + \phi(\theta)}^{66} \tag{35}$$

In the equilibrium θ is (by inverting the equation 35) a function of n. Therefore, the equilibrium job-filling probability

$$q(n) = \frac{\phi(\theta(n))}{\theta(n)}$$

is also a function of n. In particular, it is assumed that higher employment leads into lower job-filling probability.

Employers pay workers wage w_t. However, without loss of generality, the wage paid to the worker can be decomposed into two parts, corresponding to a two-part pricing contract . The worker pays a present value J_t back to the employer for the privilege of holding the job. The payment is the difference between the net benefit of having the worker and the worker's actual compensation. In equilibrium, the expected payoff exactly offsets a constant recruitment cost, γ, which the firm has to pay:

$$q(n_t)J_t = \gamma \tag{36}$$

This is the employment function, which defines employment as a function of labor market tightness and the payment. In what follows, the payment is assumed to be

[66] In the equilibrium the number of filled vacancies equals the number of destroyed jobs: $(\overline{n} - n)\phi = sn \Leftrightarrow \frac{(\overline{n}-n)}{\overline{n}} = \frac{s}{s+\phi} \Leftrightarrow 1 - \frac{(\overline{n}-n)}{\overline{n}} = \frac{\phi}{s+\phi}$.

an increasing function of slack in the economy:

$$J_t = J(x_t)$$

and a relationship between employment and x_t now follows from the equation (36). Following Hall (2011) the relationship is taken as constant-elastic:

$$n_t = \overline{n}x^{\psi}, \tag{37}$$

Empirical evidence is based on US data (see figure (10)) that suggests that unemployment closely follows capacity utilization rate. Similarly to Hall (2011) ψ is set to 1.When this is the case, the real wage is unresponsive to sudden changes in the utilization rate of capital as the effective capital labor ratio remains constant at $\frac{x_t k_t}{n_t} = \frac{k_t}{\overline{n}}$, where k_t is predetermined.

While the equation (37) that describes the equilibrium outcome in the labour market is the same as in Hall (2011), the interpretation is slightly different. Hall (2009, 2011) suggests that unemployment should be a monotonic function of the marginal revenue product of labor. He argues that the actual compensation to worker, $m_t - J_t$ (where m_t is the marginal revenue product of labour to the worker), does not respond to changes in m_t, thus leaving the payoff J_t to be highly responsive to cyclical movements in m_t. Procyclical changes in the marginal product leads into procyclical movement in the firms' recruitment efforts and thus to procyclical employment. The Finnish labour market was rigid during the time period and thus the mechanism seems reasonable (Gorodnichenko et al., 2012).

This paper links unemployment directly to slackness, x_t; the assumption is made that unemployment returns to a normal level when the slack disappears. In the exercise this is important, as lifting of investment tax credit is associated with a permanent fall in real wages (compared to the trend). Eventually full employment (full capital utilization) is reached in the model, while the transition may include a long period of unemployment (a low utilization rate of capital), because of the capital adjustment costs.

Finally, it should be noted that employment in the late 1980s may have been above the equilibrium level and thus employment may have decreased permanently during the crisis. While the focus of this paper is mainly on modeling the fall in

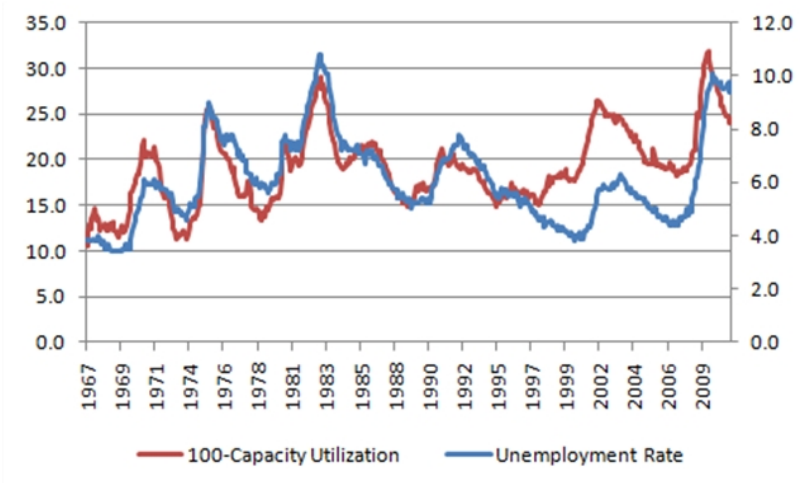


Figure 10: Capacity utilization rate and employment in US data

labor demand, the supply side reason for the rising unemployment is also shortly analyzed.

3.7 General equilibrium

In general equilibrium the household consumes according to the optimal consumption path, and firms produce and invest to meet the profitability requirement. The economy is subjected to two constraints governing the aggregate use of resources and international trade. First, trade is balanced

$$ex_t = p_t * (1 - \pi_t) * (i_{k,t} + i_{d,t} + c_{y,t})$$

where ex_t denotes the value of exports and the left hand side collects all sources of imports. It is noticeable, that the balanced trade condition does not take into account trade surplus that emerged after the crisis. The next section discusses the issue further.

The aggregate resource constraint is

$$y_t = \frac{p_t \pi_t (i_{k,t} + i_{d,t} + c_{y,t}) + ex_t}{p_{y,t}} + \frac{\kappa_k}{2} \frac{(k_t - k_{t-1})^2}{k_t} + \frac{\kappa_d}{2} \frac{(d_t - d_{t-1})^2}{d_t} + v \frac{\gamma}{q(n_t)} n_t.$$

In the first term the domestic cost share of the final goods used in Finland and the cost of exports divided by the unit cost of the domestic good equals the required resources for these uses. The last three terms are the domestic resources that are required for adjustments of capital and durables, and recruitment, respectively.[67]

All equations required to solve the dynamic model are collected in the Appendix and the dynamics are further illustrated in a diagram.

4 Data and Calibration

Similarly to Gorodnichenko et al. (2012), this paper studies macroeconomic variables after filtering out the long-run trends from the data. The behavior of the model is compared with the detrended variables. For real investment, real consumption, and real GDP (Penn World Tables) a common trend is imposed. The trend growth rate is allowed to gradually fall in order to capture the apparent fall in the long-term growth rate resulting from structural change towards post-industrial economy.

The common growth rate is estimated with the following model

$$\Delta \log(var) = \beta_{cons} + \beta_{year} year_t + Dummy_{1985-2000} + \varepsilon_t$$

where β_{cons} and β_{year} are constant and common to the three variables, while the dummy variable for the crisis period (1985-2000) is included in order to capture the potential variable-specific level shifts during the crisis. The trend is obtained by adding the series average to detrended cumulative growth without the estimated crisis effect. Seemingly unrelated regression in STATA was used.

For the non-residential investment series (Statistics Finland) the common estimated trend (β_{cons} and β_{year}) was imposed, while using the same approach in finding the effect of the crisis was otherwise used. The labor input series is the total hours engaged in the EU-KLEMS 2009 revision and the trendline is the average between 1970-1989. The real export series is from the World Bank and the trendline is the linear log trend over the years 1960 and 2010. A list of data sources

[67] Notice that the tax type financial frictions as well as the investment tax credit have purely distributional effects in the model and thus do not appear in the aggregate resource constraint.

is found in the Appendix.

Calibration of the model is mostly based on earlier literature while elements which can be calibrated based on the Finnish data are taken to match the data during the crisis period.

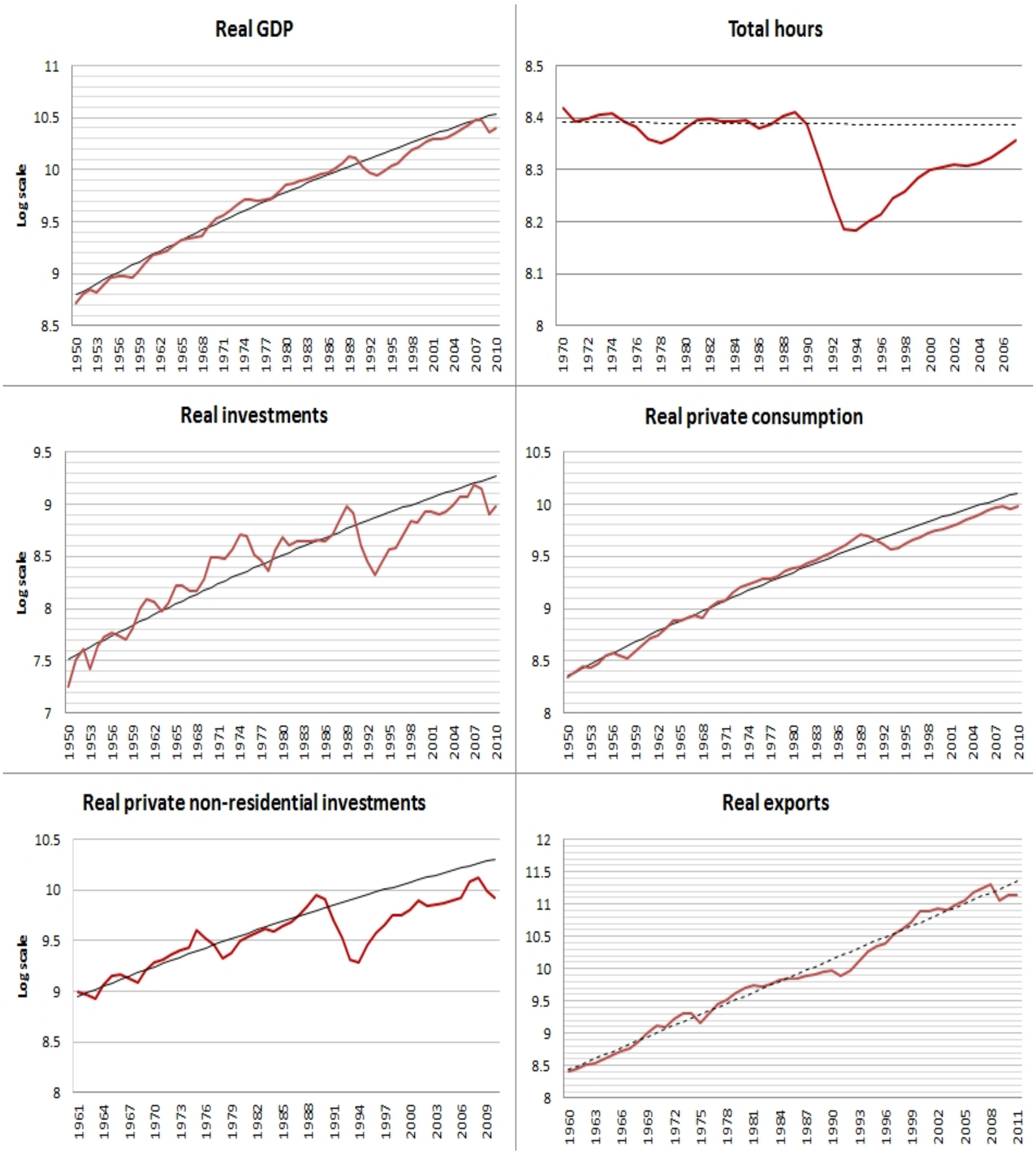


Figure 11: Fluctuations and long-run growth

Parameter	Description	Value	Source
α	Nominal labor share in production	0.649	National Accounts 90-00
κ_k	Capital adjustment cost	8	Hall (2011)
κ_d	Durables adjustment cost	8	Hall (2011)
δ_k	Capital depreciation rate	0.0188	Hall (2011)
δ_d	Durables depreciation rate	0.0129	Hall (2011)
ϕ	Nondurables consumption share	0.65	National Accounts 90-00
β	Utility discount factor	0.99	Gorodnichenko et al. (2012)
σ	Intertemporal elasticity of substitution	0.5	Gorodnichenko et al. (2012)
ω	Fraction of constrained consumption	0.2	National Accounts 90-00
$\overline{n}$	Normal employment rate		Based on 1975-1989 trend
ψ	Elasticity of employment function	1	
γ/q	Job-filling cost	0.14 of quarterly wage	Hall (2011)
υ	Separation rate	0.12	Hall (2011)
θ	Elasticity of foreign demand	8.3	Eaton and Kortum (2002)

5 Benchmark Scenarios

In the benchmark scenarios the simulation is initiated from a steady state in period 0, which corresponds to 1993q4 in the data. The latter date is chosen as it validates the use of model a, where the central bank is committed to the inflation target while recovery was just beginning. At the end of period 0 several adverse economic forces hit the economy, and the economy starts to recover from period 1 onwards. Deviations from period 0 levels in the endogenous variables are compared with the deviations of the actual economy from the long-run growth paths.

Transition dynamics are solved using the non-linear deterministic simulation algorithm in Matlab/Dynare. Errors in the model equations are smaller than the default accuracy requirements of the simulation algorithm. While the theoretical problem has an infinite horizon, in practice Dynare requires a terminal date when the numerical solution algorithm assumes that the steady state is reached. In the benchmark simulations the simulation interval is 902 quarters. To check the robustness of the results, the simulation is repeated with 1902 quarters. The maximum difference in the simulated variables with different horizons is (1.1×10^{-9}). Thus, the choice of the horizon seems not to affect the results[68].

In the initial steady state the government is committed to an investment tax credit, which is lifted at the end of period 0. To quantify the size of the credit, figure (6.3) is used. It suggests that capital stock in the year 1993 was still over 10 percent above the growth path in the late 1990s and 2000s.[69] Thus the size of the tax credit is chosen so that the artificial economy generates a fall in the capital stock of the same magnitude . The size of the tax credit is calibrated to be 7.5 percent, which incidentally is relatively close to the rise in the relative price in figure (6.4). The credit is financed with a lump-sum consumption tax. Finally, in the initial steady state, 20 percent of GDP is consumed by households that do

[68] The numerical method also requires to insert a final steady state for the algorithm. It is solved similarly to the initial steady state without the tax-credit. However, the final steady state should be considered as an initial guess for the true final state that is dependent on the transition dynamics. In practice, the difference in the simulated variables between the initial guess and the true state is found to be few percentages. However, the similarity of results with different horizons suggests that the choice of the initial guess does not affect the results.

[69] This suggests that the overcapacity problem still existed. An alternative simulation where the initial state is 1991 is considered in the next section.

not have access to the credit market later in the crisis. Numerical values for the initial steady state are reported in the Appendix.

Naturally the question arises; how much the transition is governed by the assumptions of the model. The first potential problem is that the parameters of international trade are taken to reflect the year 1995 in all periods of the simulation. This means that the relative price of the Finnish goods and the international market already include the effect of devaluation and the fall of Soviet trade. Honkapohja et. al (2009) argue that the fall of Soviet trade reduced the size of the economy by roughly -2.5 percent. Thus the choice of the benchmark year underestimates the size of the initial economy by 2.5 percent. On the other hand, trade is balanced in the model, whereas in reality the country's current account turned positive soon after the fixed exchange rate regime was abandoned. Due to the omission of a positive current account the model is likely to underestimate the size of the economy after the shocks. [70]

As the overcapacity problem is calibrated based on the observed transition path of the capital stock, this should not be a major problem. The observed transformation would have been larger without the positive current account in the late 1990s, while it would have been smaller if the Soviet Union had not collapsed. Focusing on the observed path controls these features in terms of aggregate demand , while this paper makes no attempt to match the actual pattern of the current account.

When the investment tax credit is lifted in period 1, a transition from the initial steady state towards a final steady state without the tax credit begins. The financial crisis provides another negative force in the economy. The constrained households face debt service commitments of 6.7 percent of GDP from period 1 onwards that declines by 10 percent per quarter and is removed in 1997. There is a financial friction equivalent to a property tax on both types of capital of 2 percent per year that declines at the same rate as the debt service commitment. Unlike in Hall's work (2011), excess housing capital is not considered. Finally, the real interest rate is fixed which captures the fixed inflation target of the monetary

[70] Discussing the current account requires that a stand is taken on the question of technological change , because a major contributor to the export performance was the Nokia-led information technology cluster. A priori it is not clear how this export-specific technological change affected the unemployment problem in the model and considering its role is left for future research.

policy. In practice, in the simulations the real interest rate stays at the steady state level, $\frac{1}{\beta}$.

5.1 Results

Figure (12) shows the simulated paths of key endogenous variables in the simulation where only the lift of the investment-tax credit (Overcapacity) is considered and the simulation where the financial frictions are also included (Frictions & overcapacity). The simulated variables in the latter simulation seem to capture fairly well economic contraction during the crisis. Overcapacity helps the model to capture both the depth and the persistence of the slump in terms of GDP, employment, and investments. It contributes approximately 10 percentage points of the total contraction in GDP and employment. As expected, the model does best in explaining the behavior of investments and captures the deep and persistent fall in investment activity. The difference between the simulation outcomes reflects the effect of financial frictions. The effect on GDP and employment disappears by 1998. The fall in consumption is mainly due to financial frictions and the model fails to generate enough persistence in its contraction.

Further details of the simulation with frictions and overcapacity are presented in the Appendix. Let us first consider prices. The results show a marked drop in the price of consumption during the crisis, which is solely due to a fall in the rental cost of durables. The rental cost drops almost 12 percent from the initial steady state level. Wages fall gradually. The rate, 3 percent in seven years, is roughly in line with the trend reported in Gorodnichenko et al. (2012) for real wages. After the investment tax credit is removed, the rental cost of capital as well as Tobin's q for capital start to gradually increase towards the new steady state levels.

Let us then consider quantities. After the initial fall in the price of consumption, the prices start to recover. This induces a fall in the consumption-based real interest rate due to the expected rise in CPI that generates a positive shock to the consumption of unconstrained households despite the financial frictions on durable consumption. However, this increase is too small to overcome the negative impacts of financial shocks to the consumption of credit constrained households[71].

[71] It is noticeable that a simulation with only overcapacity was made and it shows that it alone

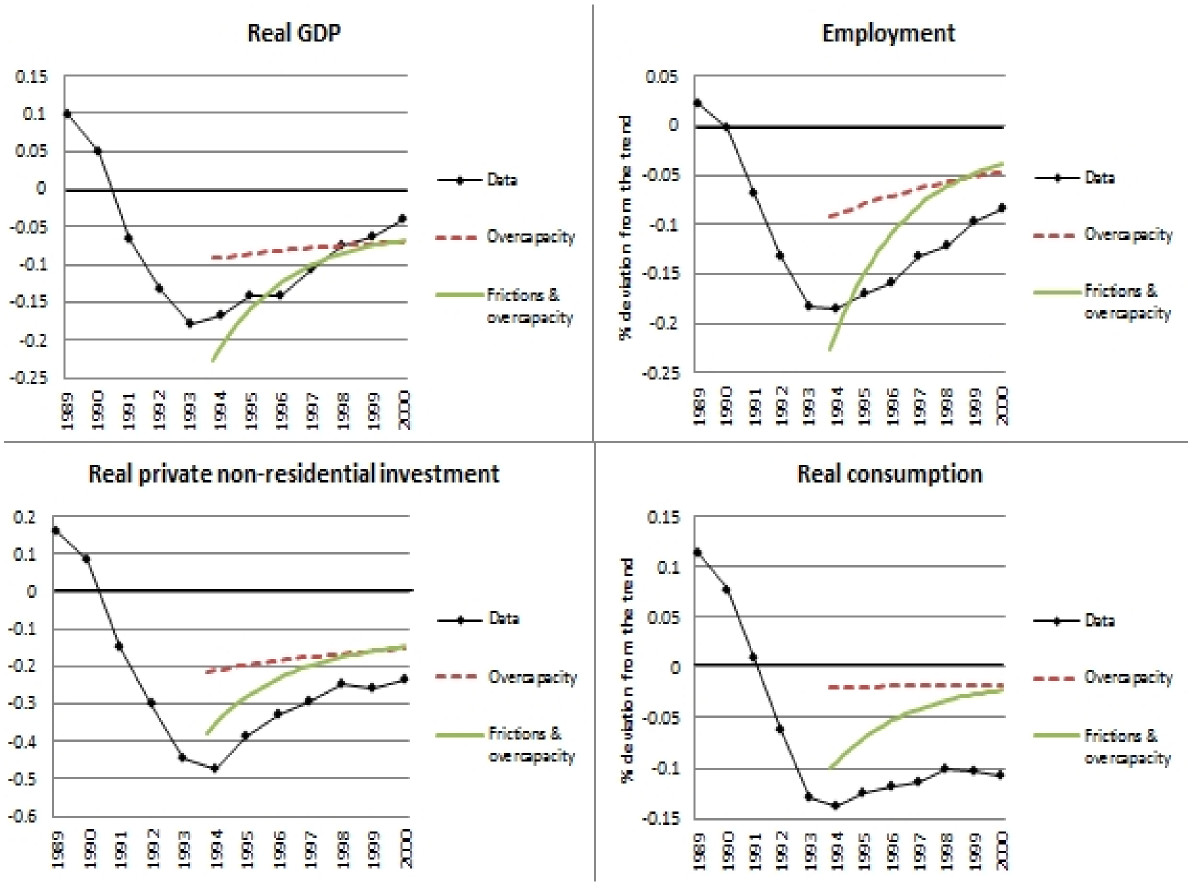


Figure 12: Benchmark outcomes

Having said that, the model has little means to replicate the persistence in the fall of consumption.

Finally, as a result of the calibration the model generates a roughly 10 percent fall in the capital stock in the long run.

5.2 Revisiting Other Explanations for the Finnish Crisis

Gorodnichenko et al. (2012) provide an interesting framework for understanding the implications of major trade shocks. By resorting to a multisector model they show how wage rigidity, together with the introduction of the service sector, provide a sizable fall in output following the permanent loss of a trading partner (the Soviet Union).

As one of the arguments for the validity of their explanation, Gorodnichenko et al. (2012) compare the depth of the crises in Sweden and Finland. In Sweden the crisis was not as severe as in Finland although the financial conditions in both countries were quite similar. As Sweden was not exposed to trade with Soviet Union, it is reasonable to believe that the depth of the Finnish crisis was contributed to by the fall of the Soviet Union. However, this paper suggests that overcapacity may explain the difference. While Sweden resorted to a very similar investment-led growth policy after the World War II, the country had already abandoned the policy by the late 1970s. According to Gorodnichenko et al. (2012) the fall below trend in the Finnish value added was 21 percent, while it was eight percent in Sweden, whereas in this paper overcapacity provides a roughly 10 percent larger contraction.

In an earlier work, Conesa et al. (2007) study the crisis with an RBC model and finds that a MFP shock was the main driving force for the crisis. However, with a standard RBC model it is hard to explain its behavior. With their methodology the lowered utilization rate of capital is accounted for as an MFP shock. While they find that, at its lowest point, MFP was roughly eight percent below the trend, in this paper the percentual deviation is

$$MFP_{\min} = 1 - \min(x_t^{1-\alpha})$$

has relatively small effect on consumption.

In the scenario with overcapacity and frictions this number is 8.6 percent.

6 Alternative Specifications

Any attempt to capture an event as complex as the Finnish Great Depression with a simplified economic model raises the question; what has been left out and what could have been modeled differently? This section discusses several issues.

6.1 Overcapacity and Flexible Prices

In the benchmark simulations prices are fixed. The following example illustrates how the overcapacity problem can be resolved while maintaining full employment when the domestic prices (and thus the real interest rate) are flexible. It also gives an impression of the magnitude of the corrective measure required to deal with the problem.

The model is solved by fixing full employment and taking domestic price as an endogenous variable. In the simulation (figure 13) the real exchange rate falls by almost 11 percent and then very gradually recovers. It is enough to induce more demand through several channels. The expected inflation increases the willingness of the unconstrained household to consume. The required return on investment is lower, which allows the investment to not fall as dramatically as in the baseline scenario. Finally, the domestic share of final goods also increases due to the improved competitiveness of domestic products. It is also noticeable that the capital stock also declines in this scenario, almost as much as in the benchmark scenarios.

Soon after the fixed exchange rate regime was abandoned, a corrective movement in the real exchange rate was indeed experienced. However, while it helped to solve the problem to some extent, the observed adjustment of the capital stock is a clear indication that it was not enough. The analysis above, combined with the comparison between Sweden and Finland, suggest that the depreciation should have been very large. Given that only the Finnish economy suffered from the overcapacity problem and financial crises in Finland and Sweden were fairly similar, the Finnish real exchange rate should have depreciated over 10 percent more than the

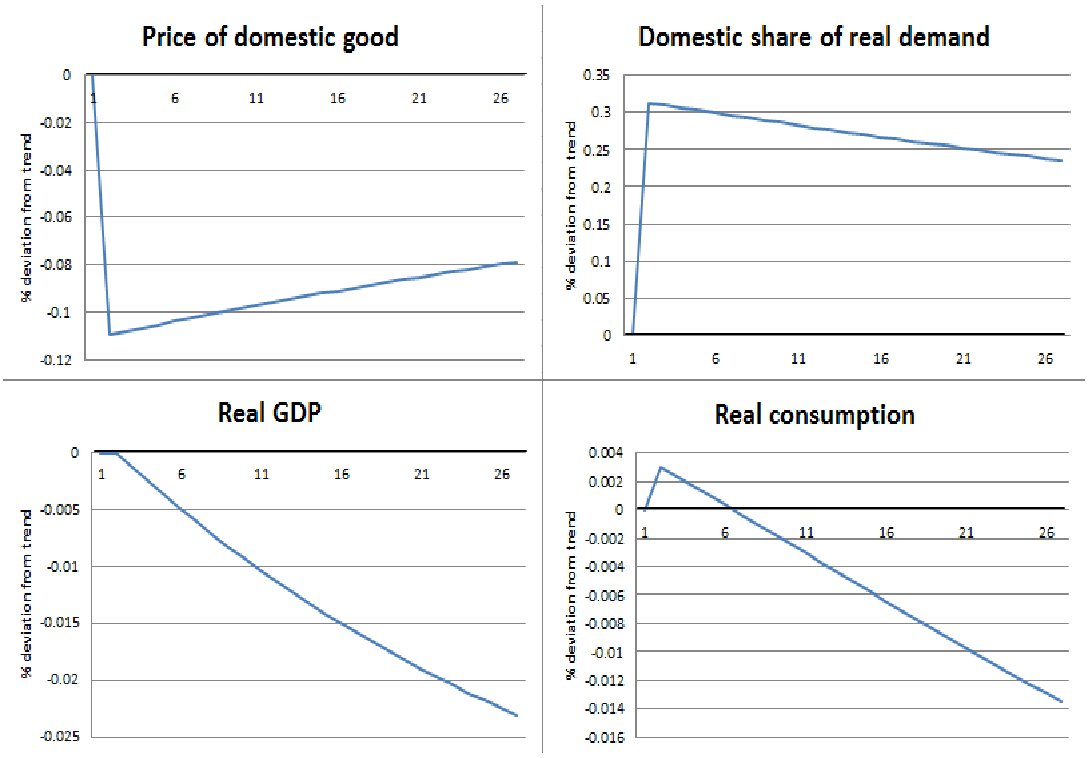


Figure 13: Flexible price

Swedish real exchange rate to resolve the problem. However, the depreciation of the Swedish Krona remained stronger than the Finnish Markka in the mid-1990s.

6.2 Labor Supply

The second issue concerns modeling of the labor market. The used model gives a demand side explanation for the unemployment problem. Yet, it has been argued that in the late 1980s employment was over its equilibrium level and structural problems relating to long-term unemployment in the late 1990s were demand driven (Honkapohja and Koskela, 1999). Using standard Greenwood, Hercowitz, and Huffman (1988) preferences, it is shown next that the demand side explanation can add persistence to the unemployment problem when overcapacity exists. In particular, the felicity function is now

$$\frac{1}{1-\sigma}(c_t - \frac{\chi}{1+\eta} n_t^{1+\eta})^{1-\sigma}$$

The model dynamics are solved while assuming that all consumers are unconstrained in order to avoid issues concerning corner solutions of utility maximization problem. The reduced form labor elasticity equation ($n = x\bar{n}$) is replaced with the first order condition

$$\chi n^{\eta} = \frac{w}{p_c}$$

that equates the ratio of marginal consumption and marginal disutility from labor with the relative price of work and consumption. Following Gorodnichenko et al. (2012), the inverse of the Frisch elasticity η is 1 , while χ is calibrated so that in the steady state the labor supply equals the full supply in the benchmark case. Wages are taken to be an exogenous state variable and decline two percentage points per quarter from the original steady state towards the new steady state.

The results suggest that, under wage rigidity, a sharp increase in unemployment is crucially dependent on the choice of labor model. In a model with the new features wages are still declining and the price of consumption is increasing but only at a very gradual pace so that the compensation for work, and thus labor supply, decreases at a very low rate. Even if the tax credit is lifted, a high real wage continue to motivate work and therefore the supply based explanation for unemployment is not a good starting point for understanding the unemployment. In contrast, in the benchmark model the capital utilization rate governs the rate of unemployment and overcapacity leads into a rapid fall in unemployment. The same is true when wages are allowed to vary in the GHH specification. In this case wages respond to the fall in the utilization rate of capital while the price of consumption remains almost constant. As the disutility of labor stays the same while the payoff of work falls, the supply of labor now falls. However, a rapid adjustment of wages was not observed during the crisis.

6.3 The Timing of the Overcapacity Problem

Until now the overcapacity problem is studied with the assumption that the simulation starts from the beginning of 1994. The latter year is preferred as the monetary policy is assumed to follow an inflation target, which was not the case before 1993. Furthermore, in the first years of the 1990s there were several other factors affecting the economy: an asset bubble in the late 1980s, the fall of Soviet trade, and the devaluation of the Finnish Markka. Considering a later starting date helps to better address the structural nature of the crisis. Nevertheless, data clearly shows that the fall in investments started from 1991, and therefore it is natural to ask whether the overcapacity problem can explain the persistence of the crisis, even if the economy is allowed to already start adjustment of the capital stock in 1991.

Thus a scenario is considered where there is a 12.5 percent investment tax credit instead of the 7.5 percent considered before. Due to the tax credit the capital stock is now 22.5 percent higher in the initial steady state, which corresponds fairly well to the overall adjustment of the capital stock during the crisis. The simulation otherwise follows parameterization in the benchmark simulation without the financial frictions. It gives a rough estimate on the full adjustment path of the capital stock when wages and prices are rigid and in the absence of other shocks.

The result suggests that the problem may indeed have a persistent effect on the economy. The overcapacity problem alone generates a 12 percentage point increase in unemployment in the starting period (1991q1). In three years time the effect is still 7.8 percentage points, 5 years later 5.5 percentage points and 10 years later 2.1 percentage points.

7 Conclusions

This paper constructs a general equilibrium model to quantify the collapse of the Finnish investment-led growth model of the early 1990s and investigates its role in the Finnish Great Depression. It reports a permanent fall in the country's investment rate and an increase in the relative price of investment. The paper shows that with reasonable parameterization and financial frictions, the lifting of an investment tax credit in the crisis conditions can explain a sizable fraction of the depression and the following long slump. In particular, it can explain the difference in the depth of the Swedish and Finnish crises, as well as the technology shock identified by Conesa et al. (2007). The findings are consistent with Karanassou et al. (2008) who also consider investments as an important factor in the Finnish crisis. Similarly to Pohjola (1996), this paper argues that the rapid fall in investments is an indication of competitiveness problems, and unemployment arises when firms face conditions that prevent them from rapidly adjusting use of capital and labor.

The first and foremost lesson of this paper is to avoid situations where rapid and large restructuring of production is needed. In this respect the Finnish experience shows how overcapacity can threaten the stability of the economy when steps are taken to reform the system. In hindsight, more progress in reorganizing production and improving the efficiency of the financial system may have been needed before beginning financial liberalization. The economy responded sluggishly to the opening financial and good markets, which later contributed to the escalation of the crisis.

While this paper considers financial frictions and the overcapacity problem separately, further research on their relationship is warranted to provide more exact policy recommendations. Nevertheless, it appears that there was not much room for action by the monetary authority during the recovery. A lower nominal interest rate would have led to depreciation of the currency and the increasing cost of the foreign denominated debt. Fräystätter (2012) illustrates this relationship for the Finnish economy. Indeed, recent literature suggests that, under binding constraints for the monetary policy, the fiscal multiplier can increase substantially. However, facing the need for structural transformation, the government was reluctant to support ailing industries. While preventing spillovers from weaker economic activity into financial markets would have been necessary, as Blanchard et al. (2009) notes, the fiscal situation rapidly deteriorated to the point where the focus of attention shifted from counter-cyclical fiscal policies to fiscal sustainability.

Another interesting avenue for future research is to consider models with endogenous technological change and financial liberalization (see, e.g., Song et al.,

2011) in the crisis context. In Finland the supply-side policies were used to support the transformation, as the Finnish government fostered R&D activities and education during the crisis. The strategy proved to be successful and transformed the country's relative advantage towards exporting high-tech goods. Indeed, it is only according to the most traditional Schumpeterian thinking that recessions are times for productivity enhancing restructuring and a necessary part of the process of economic growth. More recent literature on creative destruction suggests that financial constraints during the recessions tend to be harmful for creative processes in firms, as they are forced to cut back on their long-term R&D spending (Aghion and Marinescu, 2008).

Appendix

Utility Maximization of the Unconstrained Consumer

This appendix lays out the utility maximization problem for the unconstrained consumer. Let us write the Lagrangian.

$$
\begin{aligned}
\mathcal{L} \;=\; & \sum_t \beta^{(t)} U(c,l) \\
& +\lambda \begin{pmatrix} wl + p_d a_d + p_k a_k - p_c c - q_d i_d - q_k i_k \\ +DP^* - \epsilon D^* + DP - D \\ -\tau_k (p_k + (1-\delta_k) q_k) a_k \\ -\tau_d (p_d + (1-\delta_d) q_d) a_d \\ +T_t \end{pmatrix} \\
& +\gamma_1 (a_d^{'} - (1-\delta_d) a_d - i_d) \\
& +\gamma_2 (a_k^{'} - (1-\delta_k) a_k - i_k)
\end{aligned}
$$

where (') denotes the next period, D denotes domestic riskless bond, and DP return on bond, so that $DP' = (1+r_t^n)D$. $\overline{D}^*$ denotes the amount of bonds invested in foreign currency yielding the asset position D^* in foreign currency, where ϵ is the exchange rate $\frac{p}{p^*}$, where p is the price of domestic final good, and p^* is the price of the foreign final good. In exchange the household receives back $DP^{*\prime} = \frac{\epsilon(1+r_t^{*,n})}{\epsilon'}D^*$ units of domestic currency in the next period, where $(1+r_t^{*,n})$ is the return on bond in foreign currency. Finally, there are financial frictions equivalent to property taxes (τ_k and τ_d) on both types of capital. The taxes are returned in lump-sum transfer, T, to households.

Let us write down the FOCs for consumption

$$(c) : \beta^{(t)}U_{[c]} - p_c\lambda = 0$$

investment:

$$(i_j) : -q_j\lambda - \gamma_j = 0 \; |j = d, k$$

future assets:

$$\begin{aligned}(a_j') : \qquad & 0 = \lambda'(p_j' - \tau_j'(p_j' + (1-\delta_j)q_j') + \\ & +\gamma_j - (1-\delta_j)\gamma_j' \; |j = d, k\end{aligned}$$

and labor (in model specification, where the representative household optimizes the supply of labor):

$$-\beta^{(t)}U_{[l_j]} = \lambda w$$

Lagrange multipliers are then solved from (c) and (i_j)'s:

$$\begin{aligned}\lambda &= \frac{\beta^{(t)}U_{[c]}}{p_c} \\ \gamma_j &= -\lambda q_j \mid j = d, k\end{aligned}$$

Next, the FOCs are solved for D and D^* :

$$\begin{aligned}
\lambda &= \frac{\epsilon(1+r_t^{*,n})}{\epsilon'}\lambda^{'} \\
\lambda &= (1+r_t^n)\lambda^{'} \\
&\Leftrightarrow \frac{U_{[c]}}{U_{[c]}^{'}} = \beta\frac{p_c}{p_c^{'}}(1+r_t^n), \\
&\quad (1+r_t^n) = \frac{\epsilon}{\epsilon'}(1+r_t^{*,n})
\end{aligned}$$

The dynamic optimality conditions are found by combining $(a_j^{'})$'s with (c)'s for $j = \ d, k:$

$$\begin{aligned}
0 &= \lambda'(p_j' + \tau_j'(p_d' + (1-\delta_d)q_d') + \\
&\quad +\gamma_j - (1-\delta_j)\gamma_j' \\
&\Leftrightarrow 0 = \lambda'(p_j' + \tau_j'(p_d' + (1-\delta_d)q_d') + \\
&\quad -q_j\lambda + (1-\delta_j)q_j'\lambda' \\
&\Leftrightarrow \frac{\lambda}{\lambda'} = \frac{p_j' + (1-\delta_j)q_j' - \tau_j'(p_d' + (1-\delta_d)q_d')}{q_j} \\
&\Leftrightarrow \frac{1}{1-\tau_j'}\frac{\lambda}{\lambda'} = \frac{p_j' + (1-\delta_j)q_j'}{q_j} \\
&\Leftrightarrow (1+\frac{\tau_j'}{1-\tau_j'})(1+r_t^n) = \frac{p_j' + (1-\delta_j)q_j'}{q_j}
\end{aligned}$$

Let us denote $\frac{\tau_j}{1-\tau_j}$ $(\approx \tau_j)$ by f_j.

Furthermore, the optimality conditions are expressed in terms of relative prices and using the definition of the real interest rate, $(1+r_t^n)\frac{p_y}{p_y'} = 1 + r_t$, they become

$$
\begin{aligned}
(1+f_j)(1+r_t^n)\frac{p_y}{p'_y} &= \frac{\frac{p'_j}{p'_y}+(1-\delta_j)\frac{q'_j}{p'_y}}{\frac{q_j}{p_y}} \\
(1+f_j)(1+r_t) &= \frac{\frac{p'_j}{p'_y}+(1-\delta_j)\frac{q'_j}{p'_y}}{\frac{q_j}{p_y}} \\
(1+r_t^n)\frac{p_y}{p'_y} &= \beta\frac{\frac{p_c}{p_y}}{\frac{p'_c}{p'_y}}\frac{U_{[c'_j]}}{U_{[c_j]}} \\
1+r_t &= \beta\frac{\frac{p_c}{p_y}}{\frac{p'_c}{p'_y}}\frac{U_{[c'_j]}}{U_{[c_j]}}
\end{aligned}
$$

Lastly, this paper abstracts from further analysis of money and r_t^n is set to zero $(1+r_t=\frac{p_y}{p'_y})$.

Further Characterization of the Model

This appendix illustrates further the structure of the model. First, equations of the model are collected. Second, a diagram of the model dynamics is presented.

7.0.1 Equations

Let us write down the whole model, while prices are expressed as relative to the price of the domestic good ($p_{y,t}=1$). On the supply side the following five equations govern production and prices of production factors:

$$
\begin{aligned}
x_t &= \frac{n_t}{\overline{n}_t} \\
y_t &= An_t^{\alpha}(x_t k_{t-1})^{1-\alpha} \\
w_t &= A\alpha(\frac{x_t k_{t-1}}{n_t})^{1-\alpha} \\
p_{k,t} &= A(1-\alpha)(\frac{x_t k_{t-1}}{n_t})^{-\alpha} \\
q_{k,t} &= p_t(1-\tau)+\chi_k\frac{(k_t-k_{t-1})}{k_{t-1}}
\end{aligned}
$$

In the last three equations $p_{y,t}$ is omitted from the expression. When flexible prices are considered, $x_t = 1$.

Let us then write down the domestic real interest rate as a function of the real exchange rate, $\frac{1}{p_{w,t}}$ (the relative price of domestic good when $p_{y,t} = 1$), and the foreign real interest rate ($1 + r_t^* = \frac{1}{\beta}$):

$$1 + r_{t-1} = \frac{p_{w,t}}{p_{w,t-1}} \frac{1}{\beta}$$

When the domestic real interest rate (and thus intertemporal prices) is flexible, the relative price of domestic good varies over time. Instead of this, when the real interest rate is fixed at the level, $\frac{1}{\beta}$, the real exchange rate stays constant, as $1+r^*$ is also the growth rate of the foreign good's price. The latter assumption is made when the exogenous real interest rate is considered, while the former assumption describes the model behavior under flexible prices.

The next set of equations governs the domestic price, the share of domestic goods, and exports:

$$\begin{aligned} p_t &= (cons * p_{w,t}^{-\theta} + 1)^{-\frac{1}{\theta}} \\ \pi_t &= \frac{1}{cons * p_w^{-\theta} + 1} \\ ex_t &= p_t * (1 - \pi_t) * (i_{k,t} + i_{d,t} + c_{y,t}), \end{aligned}$$

respectively. As mentioned before, solving the initial price level requires an additional equation that governs the size of the foreign market in the steady state. A constant (cons) is used to calibrate the model to match relative prices to the data.

The pricing kernel consists of the Euler equation and the two zero arbitrage conditions arising from the household utility maximization

$$\frac{1}{1+r_t} = \beta \frac{p_{c,t}/p_t}{p_{c,t+1}/p_{t+1}} \left(\frac{\tilde{c}_{t+1}}{\tilde{c}_t}\right)^{-\frac{1}{\sigma}}$$

$$(1+r_{t-1})(1+f_{d,t}) = \frac{p_{d,t}+(1-\delta_k)q_{d,t}}{q_{d,t-1}}$$

$$(1+r_{t-1})(1+f_{k,t}) = \frac{p_{k,t}+(1-\delta_k)q_{d,t}}{q_{d,t-1}}$$

Consumption is further governed by the following static conditions and relative prices:

$$p_{c,t}\overline{c}_t = p_{y,t}(\omega y_t - s_t y_t)$$

$$p_t\widetilde{c}_{y,t} = \phi p_{c,t}\widetilde{c}_t$$

$$p_{d,t}d_{t-1} = (1-\phi)p_{c,t}(\widetilde{c}_t + \overline{c}_t)$$

$$p_{c,t} = \phi^{-\phi}(1-\phi)^{-(1-\phi)}p_t^{\phi}p_{d,t}^{1-\phi}$$

$$q_{d,t} = p_t + \chi_d\frac{(d_t-d_{t-1})}{d_{t-1}}$$

Finally, the model is closed by imposing the aggregate resource constraint:

$$y_t = \frac{p_t\pi_t(i_{k,t}+i_{d,t}+c_{y,t})+ex_t}{p_{y,t}} + \frac{\kappa_k}{2}\frac{(k_t-k_{t-1})^2}{k_t} + \frac{\kappa_d}{2}\frac{(d_t-d_{t-1})^2}{d_t} + v\frac{\gamma}{q(n_t)}n$$

7.0.2 Diagram

This subsection describes the dynamics of the model with a stylized diagram (see, figure (14)). Arrows indicate the relationship between two variables. Variables inside solid rectangles are predetermined endogenous variables (in period t on the left hand side, or in period t+1, on the right hand side). Variables inside dashed squares are exogenous variables, while variables inside circles are endogenous.

In the diagram all prices are measured relative to the price of the domestic final good. In addition, for the sake of simplicity, the labor force ($\overline{n}$) and multifactor productivity (A) (which both remain constant during the simulations) are omitted.

It is, however, noticeable that both affect the level of potential output, wage, and marginal product of capital.

The main effects of the real interest rate (R) are marked with bold lines. First, it governs changes in the relative price of the foreign good, and thus changes in the domestic share of final good. In the baseline simulation with constant prices this price change is taken to equal the price change of the foreign good (p_w) so that the share of domestic production remains constant.

The other three bold lines represent the consumption Euler equation and the zero arbitrage conditions of investment in durable and capital goods. The diagram illustrates how the general equilibrium does not necessarily generate full employment of the economy's resources. In particular, without adjustment to the real interest rate there is no direct link from low investment demand to other forms of final demand. Rather, the fall in investment does not affect international competitiveness or consumption.

Quantifying International Trade Patterns

While the model only discusses only the aggregate domestic and foreign production, it is calibrated based on a model where the tradable sector output is heterogenous. The derived functional forms are standard in open economy macromodels and leads into reasonable parameterization of the model, and thus further details of the estimation are omitted from the actual model description. Nevertheless, the estimation is discussed next in some more detail.

Let the goods be indexed by their type, $z_q \in [0, 1]$. The domestic production function is Cobb-Douglas and identical for each type expect for the MFP term which captures differences in the domestic and foreign ability to produce a particular type. Due to differences in MFP, some goods are produced in Finland and exported, while others are imported. The goods are combined symmetrically to a composite final good ($\eta_q < 1$)

$$f_q = \left(\int_0^1 f_{z_q}^{\eta_q} dz \right)^{\frac{1}{\eta_q}},$$

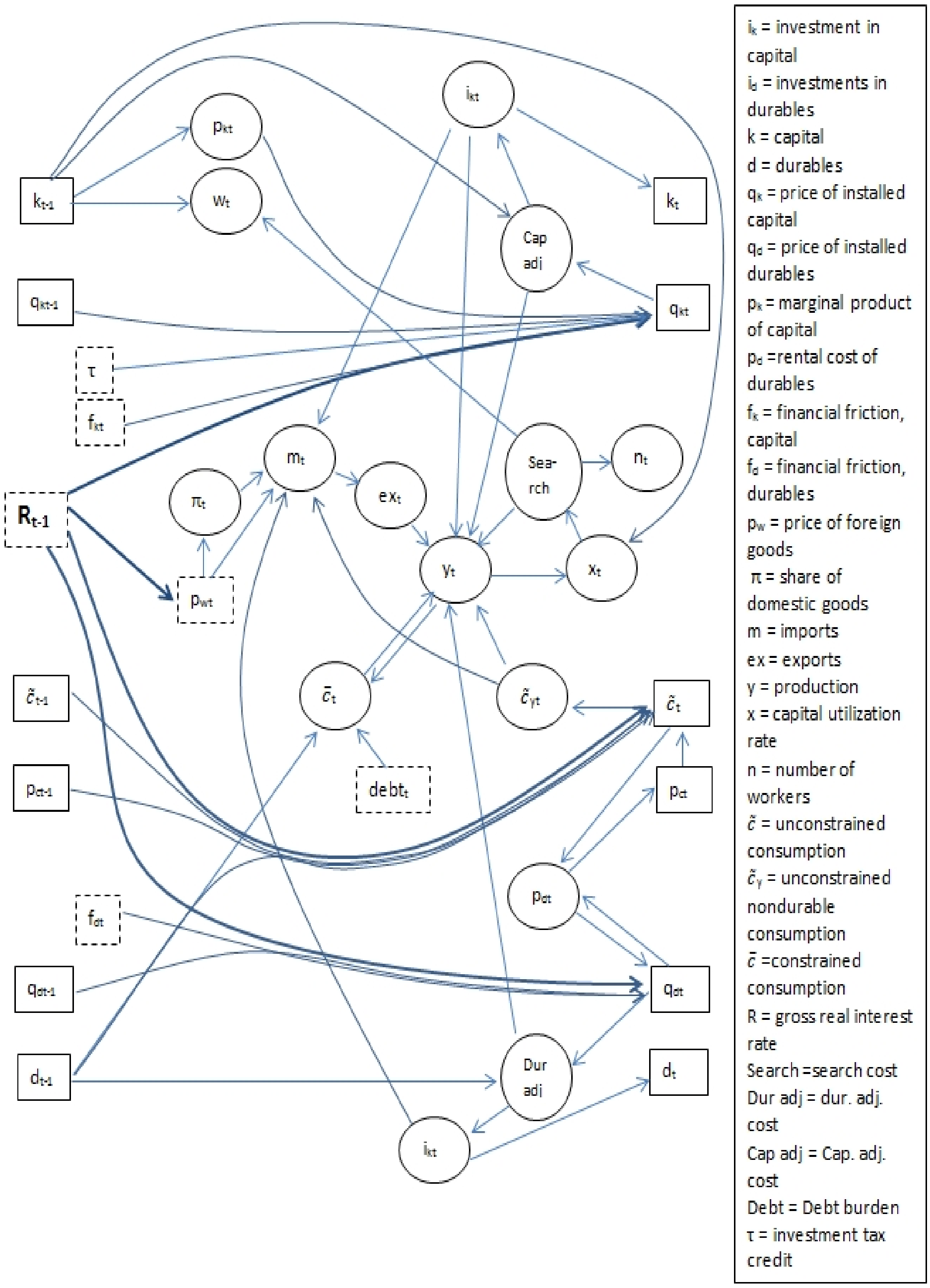


Figure 14: Model Dynamics in a Diagram

which is then used for consumption or investments purposes.

The model is based on the Eaton and Kortum (2002) framework in which the MFP distributions across countries are realizations of random variables. It is assumed that productivity $A_q(z)$ is drawn in each time period from a cumulative distribution function $\Phi_{iq}(z) = \Pr(Z_{iq} \leq A)$. When the distribution is chosen to be Frechet $\Phi_q(z) = e^{-T_q A^{-\theta_q}}$, where $T_{iq} > 0, \theta_q > 1$. The randomization has a clear economic interpretation. The draw is the maximum of a set of productivity draws that represents the best new idea from an underlying distribution of ideas. Being proportional to the mean draw from the F distribution, T measures the absolute advantage of the country in production. However, each country will have some production, as good productivity outcomes will be realized in each country. Their frequency is governed by θ, which can be interpreted as relative advantage.

Production of each class z is fully competitive and the similarity of the production makes it possible to obtain an aggregate unit cost function. It can be expressed by integration as

$$\log(UC_t) = MFP_t + (1-\alpha)\log(R_t) + \alpha\log(W_t)$$

where MFP is the inverse of aggregate mean multi-factor productivity, given by $MFP = \gamma^{-1}T^{\frac{1}{\theta}}, \gamma = (\Gamma(1-\frac{\eta_q}{1-\eta_q})\frac{1}{\theta_q})^{\frac{1-\eta_q}{\eta_q}}$. It is noticeable that the higher the variance, θ, becomes, the less the fundamental drivers of unit costs, T, and the factor prices matters for the allocation of production. Thus, θ is one of the key parameters of the model.

In the EK framework the behavior of the price minimizing purchasers can be described with tractable analytical expressions. Given the distribution of the MFP, Eaton & Kortum (2002) show how the composite good q's relative price in Finland is

$$p_t = \gamma\Phi_t^{-\frac{1}{\theta}} \tag{38}$$

where $\Phi = \sum_{k\in CN}\tau_{FIN,k}^{-\theta}UC_k^{-\theta}$, (CK being the) as EK shows. Similarly, trade patterns can be expressed as a function of wages and relative productivities. Under Fréchet distribution, the probability that the lowest price in the country is offered by the vendors in other countries can be derived from the distribution of prices.

In the EK model this probability is also the expenditure share of goods bought from other countries. The share of Finnish goods in the domestic expenditure is

$$\pi_t = \frac{UC_t^{-\theta}}{\Phi_t} \tag{39}$$

In this paper the unit costs in other countries are taken as given and thus their aggregation is reasonable. The expressions for prices and domestic shares follows, after noticing that in competitive markets unit cost equals price and defining

$$p_f^{-\theta} = \sum_{k \in \{CN \setminus FIN\}} \tau_{FIN,k}^{-\theta} UC_k^{-\theta}.$$

The quantification of the trade model is based on the estimation of bilateral trade equations. Their estimation closely follows that of Eaton & Kortum (2001) and thus its details are omitted here. It is however noticeable, that the MFP terms are measured in relative terms, in which case θ is the only calibrated variable, which is set at 8.3 based on Eaton & Kortum (2002). The set of variables used to model trade barriers is based on the gravity dataset by Head et al. (2008), provided by CEPII. The variables include tariff levels, RTA dummies, distance (six classes), common official language, border and colonial background, WTO and EU membership status as well as an importer fixed effect. The equations are estimated for the year 1995 for all manufactures. Production and bilateral trade data are taken from the TradeProd dataset, also available on the CEPII homepage.

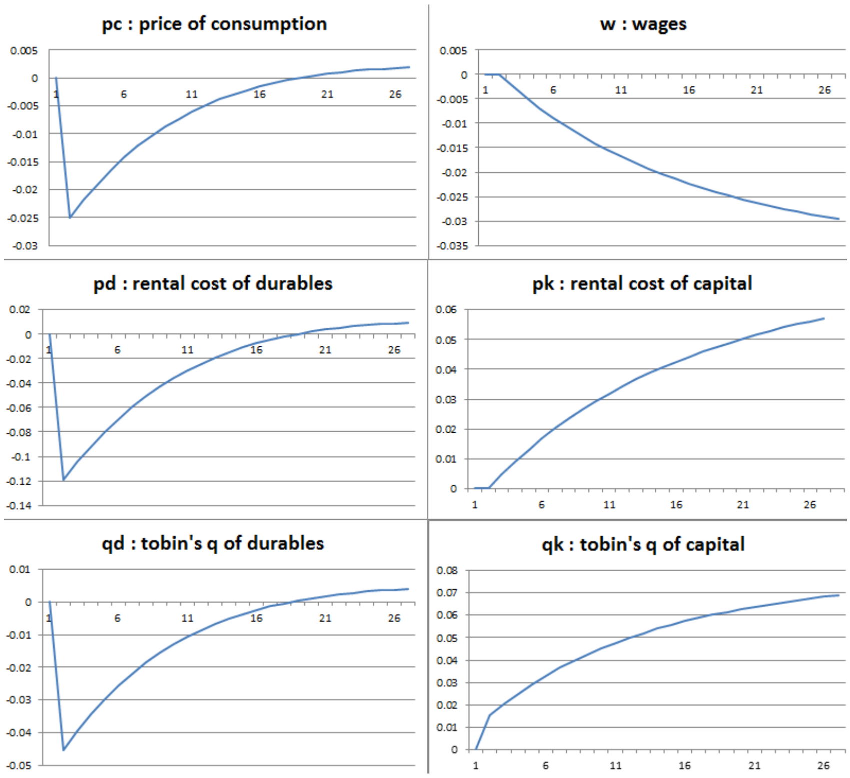
Data sources

Variable	Source
Real GDP	Penn World Table 7.2
Total hours	EU-KLEMS, 2009 edition (H_EMP)
Real Investments	Penn World Table 7.2
Real private consumption	Penn World Table 7.2
Real private non-res. investments	Finnish National accounts
Real exports	World Bank
Relative price of investments	Penn World Table 7.2 (pi/pc)
Real investment share	Penn World Table 7.2 (ki)
Non-residential capital stock	Based on PIM, Matti Pohjola (2012)
Residential capital stock	Based on PIM, Matti Pohjola (2012)
Short-term nominal interest rate	OECD country tables
Long-term government interest rate	OECD country tables
Industry-level prices, employment, output	EU-KLEMS ,2009 edition
Exchange rates	BIS
Household debt burden	Finnish National accounts
US capacity utilization rate	FED
Deposit bank spreads	Bank of Finland historical series

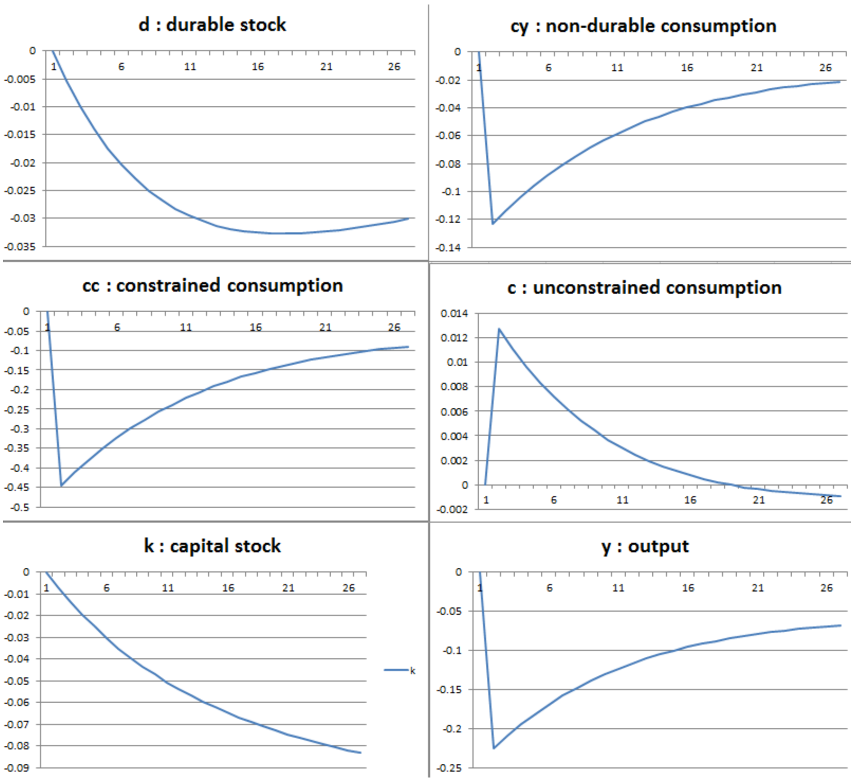
Initial Steady State

Variable	Description	Initial ss
py	price (output)	0.943
p/py	price (final good)	1.545
pc/py	price (consumption)	0.731
pd/py	rental price (durables)	0.022
pk/py	rental price (capital)	0.025
qd/py	Tobin's q (durables)	0.025
qk/py	Tobin's q (capital)	0.943
w/py	Wage	0.872
y	Output	49912
$\frac{ex}{py}$	Real exports	29184
i$_k$	investment (capital)	13065
i$_d$	investment (durables)	6966
k	Capital stock	694936
d	Stock (Durable goods)	370529
cy	Consumption (nondurables)	34090
c	Tot. consumption (unconstained)	41290
cc	Tot. consumption(constrained)	13647
π	Domestic share in final use	0.614

Details of the Simulation With Overcapacity and Financial Frictions:



Simulated prices in the quarters following 1993q4 (relative to py)



Simulated quantities in quarters following 1993q4

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