ETLA Working Papers

No. 32

23 September 2015

Tero Kuusi

The Finnish Great Depression of the 1990s

Soviet Trade or Home-Made?

Suggested citation: Kuusi, Tero (23.9.2015). "The Finnish Great Depression of the 1990s: Soviet Trade or Home-Made?". ETLA Working Papers No 32. http://pub.etla.fi/ETLA-Working-Papers-32.pdf

ETLA ELINKEINOELÄMÄN TUTKIMUSLAITOS
THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY

ISSN-L 2323–2420
ISSN 2323–2420 (print)
ISSN 2323–2439 (online)

The Finnish Great Depression of the 1990s: Soviet Trade or Home-Made?

Tero Kuusi*

September 23, 2015

Abstract

This paper reconsiders the reasons for the Finnish Great Depression. The paper argues that during the crisis Finland experienced institutional adjustments that are largely neglected by the current literature, and argues that both financial and tax shocks may have contributed to the crisis more than it has been previously suggested. It is shown by using a general equilibrium model that together these factors can generate a large and widespread fall in key macroeconomic variables, whereas the results suggest that the direct impact of the collapse of the Soviet Union may not have been as large as suggested before.

*The Research Institute of the Finnish Economy (ETLA), tero.kuusi@etla.fi. I thank Pertti Haaparanta and Matti Pohjola, as well as Yuriy Gorodnichenko, Juha Kilponen, Matti Liski, Niku Määttänen, Antti Ripatti, Tarmo Valkonen, Vesa Vihriälä, Jouko Vilmunen, Karl Walentin, and seminar participants in the HECER macroeconomic workshops, and NORDMAC 2013 conference for useful comments. This research has received research support from the Finnish Cultural Foundation, and the Horizon 2020 Framework Programme of the European union under the grant agreement number 649261 (the Firstrun project). The author assumes sole responsibility for the contents of the paper and any errors therein.

1 Introduction

Finding ways to better understand great depressions is one of the key tasks of macroeconomics. This paper revisits the Finnish Great Depression of the early 1990. The crisis was one of the worst in an industrial country since World War II and has received much attention in recent economic literature.[1] 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 depression in Finland can be explained by the fact that the Finnish economy suffered more from the collapse of the Soviet Union. The recent paper by Gorodnichenko et al. (2012) studies the Finnish crisis and comes to the same conclusion. However, their results 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. 2012, Figure 3). Unlike their simulations predict output fell substantially in all sectors of the economy and the economic contraction, especially in investments, was very persistent when it is compared to the previous growth trends.

This paper shows that Finland experienced institutional adjustments during the crisis that are largely neglected by the current literature, and argues that both financial and labor-tax shocks may have contributed to the crisis more than previously suggested. Together they can generate a large and widespread fall in key macroeconomic variables without resorting to rather strong assumptions regarding sectorial labor movement, substitutability of energy, and consumption –as made by Gorodnichenko et al. (2012). The results do not leave much room for a large, direct role of the Soviet trade shock.

Whereas Gorondichenko et al. (2012) consider the crisis in a multi-sector

[1] Aggregate production fell roughly 20% compared to the long-run trend, while for investments the contraction was more than 50%.

economy in which the Soviet collapse puts pressure on factors to shift from the Soviet to non-Soviet sector, this paper uses a fairly standard general equilibrium, one-sector model. As the data seems to contradict with the view that there were sectors in shortage of resources, the modelling choice seems reasonable. Rather, this paper's mechanism builds on the notion that the Soviet trade collapse, as well as the financial and policy shocks, had a strong lowering effect on aggregate final demand. The real interest rate should have fallen in order to generate other forms of demand, but it was not responsive to the slackness.[2] In the model firms respond to the lowering demand and the high real interest rate by cutting the use of capital. Furthermore, as the Finnish labor market was characterized with high degree of nominal wage rigidity, the adjustment to the shocks resolves itself primarily through increased unemployment, rather than an adjustment in wages. The lowered capital utilization rate creates a difference between current market wages and the reservation wages, and since firms stay on their labor demand curve, they cut employment.

In terms of the institutional adjustments this paper argues that the crisis was deeply rooted in the Finnish growth policy. The investment-led growth model - a factor that is not so far addressed with a general equilibrium model, had a marked effect on the Finnish economy both during and before the crisis. In the decades after World War II a high rate of physical investments was administratively maintained with tax subsidies and accommodative monetary policy. In fact, the investment rate was the highest among OECD countries between the years 1960 and 1990 and as a consequence the country's production capacity was very large at the onset of the crisis, while the marginal product of capital was low. Inefficiency problem escalated during the depression, the growth model collapsed,

[2]In terms of modelling the real interest rate shock and the labor-tax shock, the paper takes stock from Gorodnichenko et al. (2011), while the description of the other financial conditions follows closely Hall (2011). The export shock is modelled as a standard exogenous shock to the export demand.

and the country faced a long-lasting restructuring of production (see Pohjola, 1996; Heikkinen and Kuusterä, 2001).

The paper illustrates how the resulting, large and rapid restructuring affected the economy. The policy change is analyzed as a lifting of investment tax credit. The modeling choice reflects the removal of generous tax reserves during the corporate tax reform of the late 1980s and the early 1990s. It is argued that the reserves together with capital controls generated a tax-wedge that lowered the return on physical investments below the optimum, while their removal forced the economy to adjust to a new, higher return to capital, and depressed investment demand. The paper finds that the constructed policy change helps the model to replicate the depth and the persistence of the Finnish crisis especially in terms of a fall in investment.[3]

Furthermore, to explain the full magnitude of the economic contraction, this paper revisits some of the old narratives of 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. The boom reached its peak in 1990 and rapid contraction of the economy began. Gorodnichenko et al. (2012) addresses the financial shock as a monetary policy shock in a cash-in-advance framework by considering a temporary interest rate hike. However, this representation of the financial shock may neglect many of the multiplier effects that the financial crisis had.

This paper follows Hall (2011) in considering two adverse economic conditions during a financial crisis in addition to the real interest rate shock. First, a spread between lending and borrowing rates emerged, reflecting the agency relationship

[3]This paper acknowledges that there are other candidate explanations for the investment pattern. However, they appear not to be consistent with the evidence of a wide-spread and permanent collapse of investments as well as increase in the relative price of investment goods presented in the next section.

between investors and financial intermediates, as well as frictions in the banking system. Second, the financial crisis generated a situation where a significant share of consumption is restricted by households' ability to borrow in the crisis period. Considering these factors in addition to the interest rate shock increases considerably the contraction of consumption.

Finally, this paper revisits other fiscal shocks during the crisis, and attempts to reconcile the contradictory views in the current literature. Gorodnichenko et al. (2012) were unable to find evidence of significant changes in tax rates in the Finnish press and legislation of the early 1990s. On the other hand, Conesa et al. (2007) - also based on the Finnish government revenue data - suggests that one of the contributing factors indeed was a large income tax shock. The contradictory results are likely to be a result of the fact that the shock was mostly due to an increase in the employers social security contributions that is not visible in the data shown by Gorodnichenko et al. (2012). This paper adds the shock as an additional wedge between a rigid nominal wage and the reservation wage, and shows that this may contribute largely to the unemployment problem.

The paper is organized as follows. Section 2 revisits details of the crisis. Section 3 describes the model that is used in the quantitative analysis. Section 4 reports results of the analysis, and Section 5 concludes.

2 Details of the crisis

In this section new evidence is reported regarding the shocks that hit the Finnish economy during the 1990s crisis. However, let us start by taking stock from Gorodnichenko et al. (2012).

2.1 Taking stock from Gorodnichenko et al. (2012)

Gorondichenko et al. (2012) describe the key features of Finland's trading relationship with the Soviet Union. In particular, their analysis aims to capture the economy's response to the two shocks caused by the collapse of the Soviet Union: the sudden loss of the market for specialized exports to the USSR and the surge in the relative price of imported energy that resulted from the end of the barter trade of under-priced energy.

Gorondichenko et al. (2012) consider the shock in an economy with several sectors, the Soviet, non-Soviet and nontraded goods sectors. Their key argument is that the collapse of trade with the Soviets put pressure on factors (labor and capital) to shift from the Soviet to non-Soviet sector. This happened for two reasons: first, because the relative price of the Soviet-goods falls as a result of the collapse of the export demand, and second, majority of Finlands energy needs now had to be financed by exports of the non-Soviet good.

In these circumstances the effect of the shock can be potentially large. If factors are perfectly immobile, the output effect equals the collapse of the whole sector, while to the extent that factors can adjust, the decline in output will be smaller. Furthermore, the effect can be magnified by several other features of the economy. The trade collapse that causes the relative price of oil to rise, increased production costs also in both the non-Soviet and nontraded goods sectors. In addition, the collapse of demand in the Soviet sector reduced income and hence the demand especially for the nontraded goods. These two effects together lead to a decline in the relative price of nontraded goods and output. Rigid nominal wages amplify the contraction in demand in the short run by slowing the movement of labor across sectors. Indeed, wages in Finland are downwardly rigid and wage adjustment in the early 1990s was very slow. The rigidity of wages in Finland meant that the adjustment to the shocks resolved itself primarily through increased un-

employment, rather than an adjustment in wages (For a detailed description of the labor market, see their paper).

However, at face value the mechanism seems to be at odds with the data. In particular, the model fails to generate the actual declines in output in the non-Soviet sector (Gorodnichenko et al. 2012, Figure 3). [4] The actual dynamics suggest that the collapse was wide spread, and that the non-Soviet sector did not suffer neither from shortage of labor nor lack of production capacity. Furthermore, it is noticeable that the authors cannot replicate the massive and persistent collapse of investments in all sectors of the economy.

Therefore, this paper does not focus on the resource reallocation story, but rather on the aggregate economy. At the heart of the paper is the notion that the collapse of the Soviet union that is modelled as an exogenous shock to the volume of exports, as well as the other adverse conditions, had a strong lowering effect on final demand, and thus the market-clearing real interest rate was low. The real interest rate should have fallen in order to generate other forms of demand, but it was not responsive to the slackness. However, this paper agrees with Gorodnichenko et al. (2012) that the resulting economic contraction is greatly magnified by the wage rigidity.

2.2 Collapse of the investment-led growth model

In terms of institutional adjustments this paper is motivated by the need to explain major structural changes in investment related variables during the crisis that are hard to reconcile with the existing narratives. Figure 1.1 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 relative price

[4] Even if the authors add a large interest rate hike to the simulations, the pressure to shift resources still outweighs the negative shocks, and the non-Soviet sector does not suffer from a major decline of production.

reflects both the high cost of consumption in regulated economy and the measures to lower the cost of investments [5] For example, in the mid-1980s the price of investment relative to consumption was one of the lowest in the Western Europe. On the other hand, from the 1960s to the early 1990s the investment rate was one of the highest in OECD. Figure 1.2 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. Figures 1.3 and 1.4 show the estimates of Finnish non-residential capital stock based on the perpetual inventory method and a linear trend based on 1975-1989 observations.[6] They clearly indicate that the non-residential capital stock declined towards a new, lower growth trajectory.

Several facts indicate that the overcapacity problem may explain the dynamics. First, as the left-hand side of Figure 2.1 shows, investment rates fell substantially in almost all sectors, which is an indication of a systemic change in the economy. Second, there is direct evidence that in the decades prior to the crisis the public policies subsidized a large production capacity. The right-hand side of Figure 2.2 shows that there is a clear positive correlation between a low effective tax rate in 1989 (Kari et al., 1995, Table 4.3), and a subsequent decline in the investment rate. That is because prior to the reform the tax burden varied considerably by the capital-intensity of the sector as capital related expenditures could be deducted in taxation. The possibilities to adjust taxable profits were almost completely eliminated in the tax reform and the neutrality related to cost of capital between industries increased.

Third, in the decades prior to the crisis a large fraction of finnish firms reported

[5]The data is from the Penn World Table 7.2. The investment good item prices provided are aggregate final product prices including taxes and subsidies minus deductible product taxes.

[6]The investments data is received from the Statistics Finland in 2012 and the capital stock calculations are made by Matti Pohjola using perpetual inventory method. The same pattern can be found also in the EU-KLEMS data (http://www.euklems.net/)

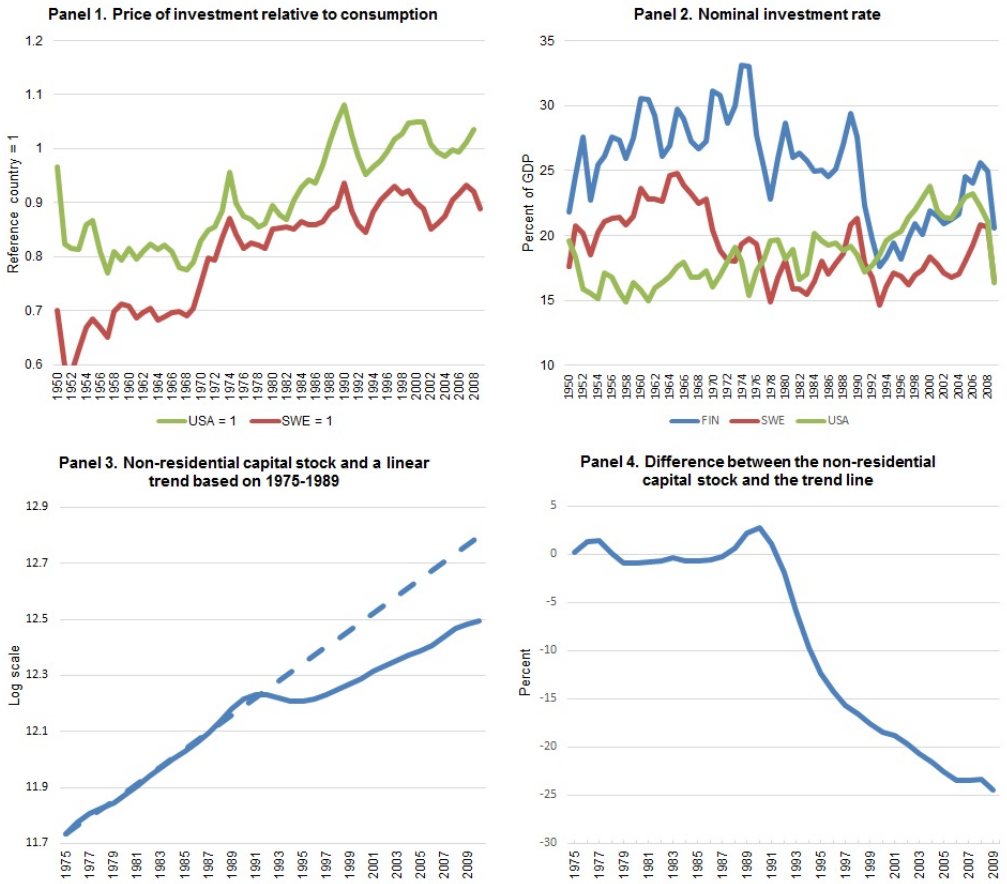

Figure 1: Investments. Sources: See Appendix

excess capacity compared to the time after the crisis, as Figure 2.3 shows[7]. This suggests that the crisis fostered a major change in attitudes towards maintaining a large production capacity. The overcapacity problem escalated in the early 1990s when the fraction of firms reporting excess capacity was as high as 90%, while the share fell to 20% during the 1990s.[8] The reports again suggests that the problem

[7]Based on a business tendency survey that is conducted annually by the Confederation of Finnish Industries (EK) for roughly 500 firms in manufacturing. The referred series is BTEOL-RPM:B3AP.

[8]It should be noted that the comparison is not completely without problems, as the questioneer has slightly changed over the years. Until 1992q4 the question was: "Is there excessive capacity in our firm? yes / no". Afterwards the question was changed to "Is there too much capacity in

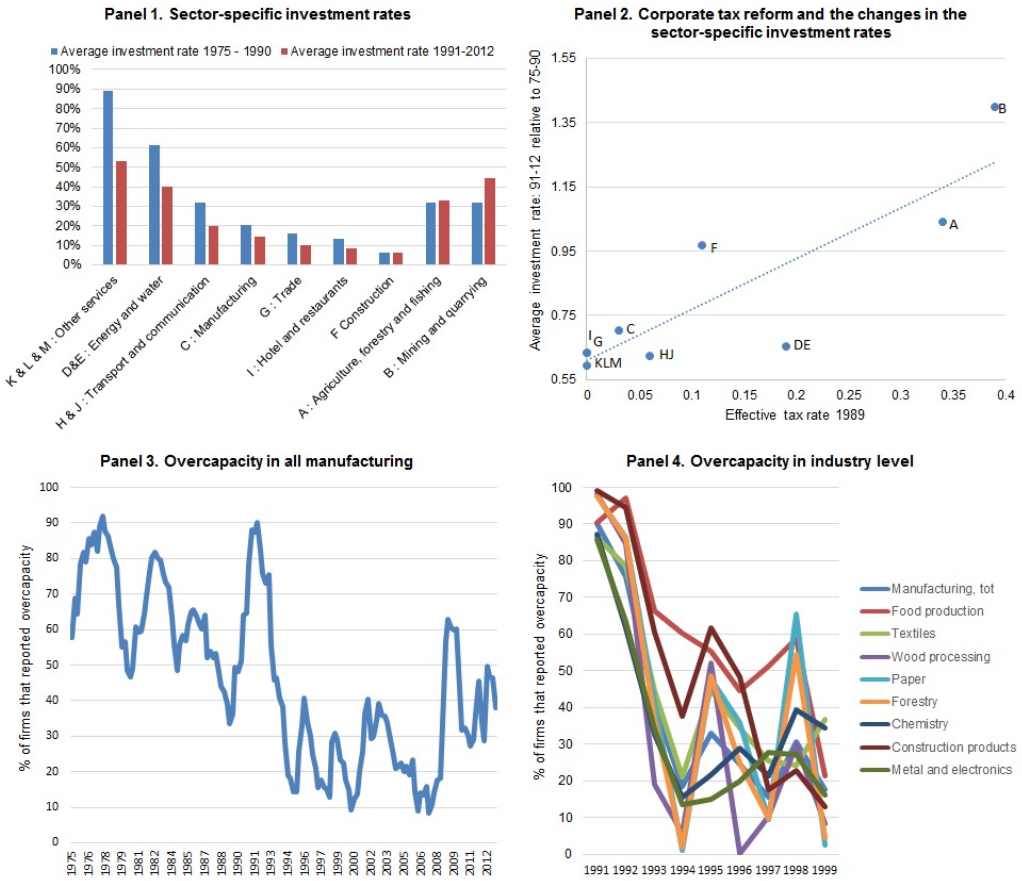

Figure 2: Sector-specific investment rates (relative to value added). Sources: See Appendix

was wide-spread. The industry-level shares of the firms that reported overcapacity on Figure 2.4 shows that in all industries the share exceeded 80 % in the early 1990s and it subsequently fell to the new low level relatively uniformly.

There were several features of the Finnish public policies that contributed to the overcapacity problem. Before the major reforms of the tax system in the late 1980s and the early 1990s generous inventory and investment reserves

your firm? Answer: too much / enough / too little". Prior to 1993 the share of firms answering "yes" is reported while thereafter the answer "too much" is used. Furthermore, there was a reported change in the industry classification in 1996.

considerably reduced the corporate taxes collected. At the same time capital flows were tightly regulated and interest rates were set administratively below the market-clearing levels to ensure a supportive and stable investment environment (see, e.g., Korkman, 1992; Pohjola, 1996; Heikkinen and Kuusterä, 2001).

Major reforms removed institutional means of maintaining the old growth policy in the late 1980s and early 1990s. Almost all the reserves were removed either in 1992 (investment reserves) or 1993 (inventory and operation reserves)[9], while sizable reductions to the system were already conducted since 1986. The timing of their complete removal fits well with the timing of the collapse of the investment shares.

The policy change is here modeled as lifting of an investment tax credit that is financed with a lump-sum tax collected from the owners of the firm (households) and returned back as a part of the corporate profits. While the tax credit is maintained, it results in a tax-wedge that lowers the return on investments below the optimum because the investors do not take into account the cost of the tax credit when they make the investment decision. Pohjola (1996) analyzes country-level, 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. On the other hand, the lump-sum tax captures the effect of the forced saving aspect of the regulated financial market and the fiscal policies that channeled resources towards industrialization.

The size of the tax credit can be approximated in different ways. One way is to measure the change in the relative (to consumption) price of investment prior to the crisis and afterwards. The observed change is roughly 10 to 15%.

[9]The reserves consisted of inventory reserves (deduction that is claimed on inventoried assets which have undergone some amount of depreciation or deterioration, or are considered obsolete in terms of the operation of the business), operational reserves (deduction that firms could make from wage expenses similarly to inventory reserves), and investment reserves (deductions based on current or expected investments).

Alternatively, it is possible to address the size of the investment tax credit based on the details of the tax reform. In the Appendix it is estimated that the reserves accounted for roughly 15.8% of the total value of business capital investment in 1989.

Finally, this paper acknowledges that there are other candidate explanations for the investment pattern. Gorodnichenko et al. (2012) emphasize the embodied nature of capital (physical and human) which limited the flow of resources from the Soviet sector to other sectors and may have prohibited new investments. On the other hand, Freystätter (2011) studied the Finnish crisis with a DSGE model based on the financial accelerator framework. Compared to Gorodnichenko et al. (2012), Freystätter (2011) argues that the framework 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. Technological change and the associated structural transformation is yet another candidate to explain such changes in the investment behavior (Acemoglu et al., 2006; Conesa et al., 2007; Song et al., 2011).

However, the other explanations appear not to be consistent with the presented evidence. First, a wide-spread and permanent collapse of investments is hard to reconcile with the Soviet trade shock per se (Gorodnichenko, 2009, Figure 5), or an external shock in general because the crisis did not have a permanent effect on the country's ability to export. Second, even if business capital was lost during the crisis, as Freystätter (2011) suggests, it is difficult to explain why investment demand never recovered after the adverse financial conditions ended. Finally, technology as an explanation is not easily reconciled with the wide-spread and rapid transformation experienced in the Finnish economy during the late 1980s and the early 1990s.[10]

[10]It could be anticipated that the relative (to US) price of investment goods would fall as a result of the economic liberalization and increasing inflow of international technology in the 1980s.

2.3 Financial shocks and the rise of the social security contributions

One of the key contributing factors to the crisis' onset was the real interest rate hike of the early 1990s. The magnitude of the economic contraction is crucially dependent on the real interest rate, as it is a key determinant of final demand. To capture its effect, Gorodnichenko et al. (2012) use exogenous real interest rate shocks that capture the monetary policy shocks in a simple cash-in-advance set-up.

However, while the shocks reflect partially the financial crisis aspects of the depression, it is noticeable that there were other financial factors in play that are not considered by Gorodnichenko et al. (2012). First, a large spread between lending and borrowing rates emerged, reflecting the agency relationship between investors and financial intermediates, as well as frictions in the banking system. Second, the financial crisis generated a situation where a significant share of consumption was restricted by households' ability to borrow in the crisis period that followed from the collapse of their existing capital stock's collateral value and the jump in the value of currency loans.

Figure 3.1 shows the different financial conditions. First, the real interest rate is measured as the difference between the 6 mth Helibor and CPI inflation. The additional economic conditions are measured as deviations from the observed long-run trends. The financial friction is calibrated as the deviation of the interest rate spread between lending and borrowing rates from its average in the available IMF data (1981-2004). The second factor is the forced saving that is measured as the deviation of the debt burden to GDP ratio from its average in 1975-2010. The idea is that all income of the constrained households goes to consumption, which

It is much harder to explain why technological change would have increased it. Furthermore, some of the largest changes in the investment rates were seen in the service sector which was not on the frontier of the technological change at the time of the crisis.

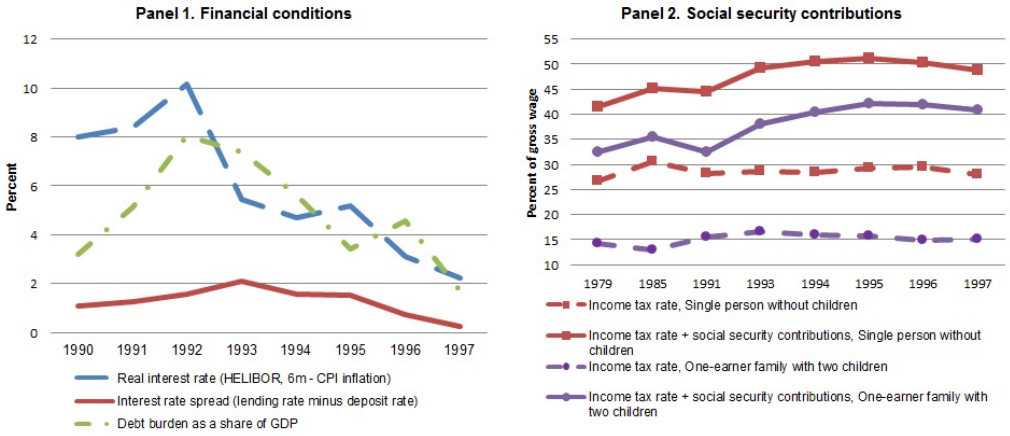

Figure 3: Evidence on the financial and labor-tax shocks

is restricted by their debt burden (interest payments and amortization minus the amount of new loans). [11]

In terms of taxation Gorodnichenko et al. (2012), contrary to Conesa et al. (2007) were unable to find evidence of significant changes in tax rates in the Finnish press and legislation of the early 1990s. Furthermore, it is worth emphasizing that the corporate tax reform was mainly structural. Prior to the reform the statutory corporate income tax rate was very high (on average 50 per cent in 1987), but while after the reform the corporate tax rate was lower for both distributed and for retained earnings (28% from 1996), the effective tax rate remained close to the pre-reform rate due to the removal of the reserves.

The question, however, remains, what explains the different views taken by Conesa et al. (2007) and Gorodnichenko et al. (2012)? Figure 3.2 shows the income tax rate as well as trends in the social security contributions of the employer for two, illustrative household types. They show a roughly 5 % increase in the

[11] 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% of all household income. Following Hall (2011) deleveraging is assumed to restrict the consumption of constrained households.

social security contributions during the crisis. The contributions do not affect the marginal income tax rates and therefore do not appear in the graphs shown by Gorodnichenko et al. (2012).

Similarly to Gorodnichenko et al. (2012) it is expected that the tax shock will increase the problem of downward wage rigidity. With inflexible wages, there is a difference between current market wages and the reservation wages that would be received by the workers on an equilibrium without labor frictions. In conditions where the nominal wage is downward rigid, the social security contributions generate a further wedge between the agreed wage and the actual cost of employment.

3 A Quantitative Model of the Finnish Crisis

This section introduces the general equilibrium models that are used in the quantitative exercise. The benchmark specification includes features that allows to model the investment-tax credit and the real interest rate shocks. The additional shocks are considered in an extended model that has credit constrained households, durable consumption goods, and financial frictions. As usual in the Great Depression literature that deals with large unexpected shocks, the considered model is deterministic. That is, while the shocks come as a surprise, the economic agents do not expect further surprises in the future.

3.1 A model with the investment-tax credit

In the benchmark model a representative household engage in saving and consumes according to the optimal consumption path, as well as supplies labor. A representative firm operating in competitive markets produces a domestic good that is exported, combined together with a foreign good into a domestic final good according to a CES aggregator, or used directly as a resource of capital develop-

ment projects. The domestic final good can be used as a non-durable consumption good or a capital investment good. The investment goods are transformed by capital producers into capital in the period following their creation, and rented out to the representative firm.

3.1.1 Households

The households choose their paths of consumption according to the standard intertemporal utility function with Greenwood, Hercowitz and Huffman (1988) preferences

$$\sum_{t=0}^{\infty}\beta^t \frac{(\widetilde{c}_t - \chi \overline{n}_t^{1+\nu})^{1-1/\sigma}}{1-1/\sigma}, \tag{1}$$

where σ is the intertemporal elasticity of substitution, $\tilde{c}$ is consumption, $1/\nu$ is the Frisch elasticity of labor supply, and χ is the the scaling parameter of disutility from working, and $\overline{n}_t$ is the employment that the household provides. The household can invest in foreign bonds as well as in capital assets.

Furthermore, a fraction of the households remain involuntarily unemployed in which case their labor input is 0. The actual employment (in the representative household framework where the number of households is set to 1) is $n = \overline{n}_t * f^{emp}$, where f^{emp} is the share of employed households. The households are fully insured against the unemployment risk and their aggregate budget constraint is

$$w_t n_t + p_{k,t} a_{k,t} - p_{c,t}\tilde{c}_t - q_{k,t} i_{k,t} + (1 + r_{t-1}) D_{t-1} - D_t - T_t = 0 \tag{2}$$

where w is wage, $p_{c,t}$ is the price of the consumption good (= price of the domestic final good),p_k is the rental cost of the capital assets that sums up to the capital stock of the economy $a_k = k$, q_k is the cost of newly installed capital $i_{k,t}$ that the household acquires at the end of the period, D_t denotes riskless bond

and $(1+r_t)$ its real return.[12] T is the lump-sum tax that finances the investment tax credit.

The optimization yields the standard first order condition for labor supply

$$\frac{w_t}{p_{c,t}} = \chi \overline{n}_t^{\nu} \tag{3}$$

Furthermore the household price assets with returns measured in units of output by the discounter

$$\mu_t = \beta \frac{p_{c,t}}{p_{c,t+1}} \left(\frac{\tilde{c}_{t+1}}{\tilde{c}_t} \right)^{-\frac{1}{\sigma}}, \tag{4}$$

and in the optimum:

$$1 + r_t = \frac{1}{\mu_t} \tag{5}$$

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

$$(1+r_t) \quad = \quad \frac{p_{k,t+1} + (1-\delta_k) q_{k,t+1}}{q_{k,t}} \tag{6}$$

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 $\frac{1}{q_t}$ units of the investment good in the end of the period t. Its value in $t+1$ consists of the rental price in $t+1$, $p_{k,t+1}$ and the amount at which the good sells at the end of $t+1$, $q_{k,t}$, after the depreciation

[12] The model builds on the standard RBC model and the real interest rate is defined as the inverse of the inflation of the domestic good $1 + r_t = \frac{p_{y,t}}{p_{y,t+1}}$. The model is straight-forwardly extended to allow for foreign bonds in which case $1 + r_t = (1 + r_t^*) \frac{\epsilon_{t+1}}{\epsilon_t}$ where ϵ_t is the exchange rate, and r_t^* is the net return to foreign bond.

$(1-\delta_k)$.

3.1.2 Firms

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

$$\max_{n,k} p_{y,t}y(x_tk_{t-1}, n_t) - w_tn_t - p_{k,t}x_tk_{t-1} \tag{7}$$

where y denotes the production function of the domestic good, $p_{y,t}$ is the price of the domestic good,x_t is the utilization rate of the economy's available business capital stock k_{t-1} (constructed at t-1), w_t is the per worker wage, n_t is the number of workers, and $p_{k,t}$ is the rental cost of capital. The firm can adjust freely its fully utilized, rental capital stock (x_tk_{t-1}) to guarantee full demand for its products and adequate return to the marginal unit of capital.[13]

Throughout the exercise Cobb-Douglas production function is assumed: $y_t = An_t^{\alpha}(x_tk_{t-1})^{1-\alpha}$, where α is the nominal cost share of labor in production and A is the multifactor productivity under full utilization rate of capital. Then, the first order conditions with respect to x_tk_{t-1} and n_t are:

$$w_t = p_{y,t}A\alpha(\frac{x_tk_{t-1}}{n_t})^{1-\alpha} \tag{8}$$

$$p_{k,t} = p_{y,t}A(1-\alpha)(\frac{x_tk_{t-1}}{n_t})^{-\alpha} \tag{9}$$

To analyze the export shock, and to quantify correctly the size of the other shocks, the economy is open to international trade. The domestic good is ex-

[13]The number of firms that reported overcapacity sharply fell after its peak in the early 1990s accompanied by a wave of bankruptcies. This suggests that the overcapacity problem become rapidly external to the operational firms, and thus it is assumed that the capital stock of the representative firm can adjust freely. Decisions about the optimal size of the capital stock are made by capital producers that are discussed in the next subsection.

ported, combined together with a foreign good into a domestic final good, or used directly as the resource of labor and capital adjustment. The domestic final good is a CES aggregate of domestic and foreign good, its price being

$$p_t = (p_{y,t}^{-\theta} + p_{w,t}^{-\theta})^{-\frac{1}{\theta}} \tag{10}$$

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.[14] The cost share of the domestic good in the domestic final product is also a function of relative prices

$$\pi_t = \frac{p_y^{-\theta}}{p_w^{-\theta} + p_y^{-\theta}}. \tag{11}$$

3.1.3 Market clearing

The reaction of the Finnish economy to the different shocks cannot be examined without understanding the special nature of the Finnish labor market. It is notable for its high degree of unionization. In the early 1990s approximately 85 percent of workers belonged to unions and almost 95 percent of workers were covered by collective agreements (Bockerman and Uusitalo 2006; Gorodnichenko et al. 2012). Furthermore, unions did not agree to cut nominal wages in 1992-1993, which were the peak years of the depression. Instead, wages were frozen at the 1991 level, and given that inflation was quite moderate in the 1990s and there was a positive drift in the nominal wages, real wages fell only to a limited extent (see Gorodnichenko et al. 2012 for details).

Similar to Gorodnichenko et al. (2012) it is assumed that the nominal wages are exogenous in the first years of the crisis. In particular, the wage is a linear

[14] Since the model is defined in real terms, the price ratio $\frac{p_t}{p_{y,t}}$ governs how many units of the domestic good have to be supplied in exchange of one unit of the final good.

combination of the exogenous component and the endogenous reservation wage:

$$w_t = \xi_t w_t^{exo} + (1 - \xi_t) w_t^D \tag{12}$$

where ξ_t is an exogenous variable that governs the weight given to the exogeneity of the wage and w_t^{exo} is the exogenous component of the wage. In an equilibrium without labor frictions, the wage received by workers is equal to their reservation wage w_t^D that is consistent with full labor supply $n = \overline{n}$ at the period t., i.e.

$$w_t^D = p_{y,t} A \alpha (\frac{x_t k_{t-1}}{\overline{n}})^{1-\alpha} \tag{13}$$

In the model the real wages decline linearly at a pace that is calibrated based on the empirical data. With this type of wage rigidity the reservation wage may not be equal to the wage actually received. There is a difference between current market wages and the reservation wages and since firms stay on their labor demand curve, they cut employment.

Furthermore, the overcapacity problem can turn into long-lasting slack when the capital stock adjusts slowly. A reasonable way to model adjustment costs is to assume that there are costly capital development projects that are needed to increase the marginal product of capital. It is assumed that the projects are operated competitively by capital producers that use domestic good to adjust the size of the capital stock. [15]

The aggregate business capital stock evolves according to

[15]The modelling choice reflects the fact that the overcapacity problem and the associated adjustment costs become external to operational firms relatively rapidly. Firms have to pay internal costs before they use the newly purchased machinery, while external costs are pecuniary cost that the users pay to the producers of capital goods. However, from a macroeconomic perspective there should be little distinction between internal and external adjustment costs, as costs that are external to the firm are not external to the economy. Before the resulting slack in the economy is resolved by the costly projects, the slack results in unemployment of labour.

$$k_t = i_{k,t} + (1 - \delta_k)k_{t-1}, \tag{14}$$

where $i_{k,t}$ is the business capital investments, δ_k, is the depreciation rate. The projects maximize profits subject to a quadratic adjustment cost:

$$\max_{i_{k,t}} \left(q_{k,t} i_{k,t} - (1 - \tau) p_t i_{k,t} - p_{y,t} \frac{\chi_k}{2} \frac{(k_t - k_{t-1})^2}{k_{t-1}}\right) \tag{15}$$

where τ is the investment tax credit (only in the initial steady state), p_t is the price of the investment good (= domestic final good), and χ_k is the capital adjustment cost parameter. Under zero profits the maximization problems yield the following first order condition for $i_{k,t}$:

$$q_{k,t} = p_t(1 - \tau) + p_{y,t}\chi_k \frac{(k_t - k_{t-1})}{k_{t-1}} \tag{16}$$

where q_k is Tobin's q, i.e., the shadow price of installed capital.

3.1.4 General Equilibrium

In general equilibrium the household supplies labor, consumes according to the optimal consumption path, and invest to meet the required return governed by the real interest rate. Firms produce goods, hire workers, and rent business capital.

In the first years of the crisis the volume of exports is considered exogenous. A balanced trade condition is enforced at later periods of the simulation. In particular, exports are a linear combination of the exogenous component and the balanced trade condition:

$$ex_t = \xi_t ex_t^{exo} + (1 - \xi_t)(p_t * (1 - \pi_t) * (i_{k,t} + \tilde{c}_t)) \tag{17}$$

where ex_t denotes the value of exports and the volume of exports in terms

of domestic good is measured as $\frac{ex_t}{p_{y,t}}$. ξ_t is the same, exogenous variable that governs the weight given to the exogeneity of the wage. ex_t^{exo} is the exogenous export demand. The second term on the left-hand side collects components of the balanced trade condition (the value of imports). When $\xi_t = 1$, exports are fully exogenous and when $\xi_t = 0$, the balanced trade condition holds.

The aggregate resource constraint is

$$y_t = \frac{p_t \pi_t (i_{k,t} + \tilde{c}_t)}{p_{y,t}} + \frac{ex_t}{p_{y,t}} + \frac{\kappa_k}{2} \frac{(k_t - k_{t-1})^2}{k_t}. \tag{18}$$

The first term is the volume of domestic goods that are used as a part of the domestic final good. The second term measures the volume of exported final goods. The third term includes the domestic goods that are required for adjustments of capital.[16]

3.1.5 The Benchmark Parameterization

Following Gorodnichenko et al. (2012) that uses a similar model of the Finnish economy the discount factor β is set to 0.99 so that the real rate of return is 4 percent per annum, assuming the standard stationarity condition that equates the rate of interest with the rate of time preference. The intertemporal elasticity of substitution σ is set at $1/2$ which is the standard value in RBC literature.

The nominal labor share of production $\alpha = 0.649$ is the measured average over the years 1990-2000 in the National Accounts. The calibration of the depreciation rate of business capital $\delta_k = 0.0162$ is the weighted average of the different capital types' depreciation rates in 1990-2000. The rates are the same that are used by the Statistics Finland to construct the capital stock series.

Another key calibrated parameter is the adjustment cost of the business capital

[16] Notice that the investment tax credit have purely distributional effects in the model and thus do not appear in the aggregate resource constraint.

stock, κ_k. While there is no evidence that the adjustment cost would be significantly different in Finland compared to other countries[17], the literature provides a wide scale of possible values of the parameter. In the baseline scenario its value is set at 8 following Hall's (2011) calibration of a very similar model of the US economy. While the calibrated value is at the upper side of the possible parameter values' range, smaller and larger values are tested as a robustness check. The results are not very sensitive to the chosen parameter value.

Finally, the elasticity of foreign demand $\theta = 8.3$ is calibrated based on Eaton and Kortum (2002), while the export share of domestic production is calibrated to match the share of exports prior to the crisis, roughly one quarter.

3.2 The additional financial and fiscal shocks

The benchmark model is augmented in several ways in order to model the additional shocks. First, 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 now invest in two types of capital, the business capital, and durable consumption (housing) goods. 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 of the both household types 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. The credit constrained (and similarly to the unconstrained) households' consumption, its price, and the demand for the nondurable goods component of

[17]Using Bayesian estimation Pietilainen (2010) finds that the Finnish investment adjustment costs are not significantly different from other euro countries

consumption satisfies respectively

$$\begin{aligned} \overline{c}_t &= = \overline{c}_{y,t}^{\phi} \overline{d}_{t-1}^{1-\phi} && (19) \\ p_{c,t} &= \phi^{-\phi}(1-\phi)^{-(1-\phi)} p_t^{\phi} p_{d,t}^{1-\phi} && (20) \\ p_t \overline{c}_{y,t} &= \phi p_{c,t} \overline{c}_t && (21) \end{aligned}$$

where $p_{d,t}$ denotes the rental cost of durables. The total nondurable consumption and total consumption of durable services are respectively

$$\begin{aligned} p_t c_{y,t} &= \phi p_{c,t}(\widetilde{c}_t + \overline{c}_t) && (22) \\ p_{d,t} d_{t-1} &= (1-\phi) p_{c,t}(\widetilde{c}_t + \overline{c}_t) && (23) \end{aligned}$$

The unconstrained households choose their paths of composite consumption according to the intertemporal utility function as before. A zero arbitrage condition holds now for the return on investment in durable and capital goods:

$$\begin{aligned} (1+r_t)(1+f_{d,t}) &= \frac{p_{d,t+1} + (1-\delta_k) q_{d,t+1}}{q_{d,t}}. && (24) \\ (1+r_t)(1+f_{k,t}) &= \frac{p_{k,t+1} + (1-\delta_k) q_{k,t+1}}{q_{k,t}} && (25) \end{aligned}$$

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 real interest rate.

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

$$p_{c,t}\bar{c}_t = p_{y,t}(\omega y_t - s_t y_t) \tag{26}$$

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.

Furthermore, the introduction of the employer's social security contributions is considered. It is assumed to build a wedge between the downward rigid nominal wage w^{exo} and the reservation wage. In equation 8 the exogenous nominal wage is replaced with $(1+\tau^{ssc})w^{exo}$ where τ^{ssc} is the contribution rate.

Resource constraint of the economy is augmented to include investments in durables, adjustment costs of durable goods, as well as the credit constrained consumption. The financial friction and the social security contributions are modeled as a tax that is returned back to the household as a lump-sum tax rebate, and thus it has purely distributive effect.

Finally, let us discuss the parameterization with the additional shocks. Non-durable consumption share ϕ is set at 77.5% of total household expenditures reflecting the combined share of housing rental costs and durable expenditures in the year 1990. The fraction of constrained consumption ω is 20% based on the early 1990s data. The depreciation rate of durables $\delta_d = 0.0129$ is taken from Hall (2011). The adjustment cost of the business capital stock is used also for consumption durables, $\kappa_d = 8$.

4 Quantitative Analysis

In this section the simulated scenarios are first described and then the results of the quantitative analysis are reported.

4.1 Simulated scenarios

4.1.1 The benchmark scenario

The benchmark scenario is initiated from 1990q4; a quarter before the Soviet trade shock hits the economy. In 1990q1 the Soviet and the western export shocks decreases export demand by 10 %; a number that captures the average decline in exports between 1990 and 1991-1992. Furthermore, following Gorodnichenko et al. (2012) the financial crisis is captured by considering two real interest rate shocks in 1991q4 and 1992q2 that lift the real interest rates by 2 percentage points. The interest rate shocks come as a surprise and decay at a rate 10% per quarter.[18] In the initial steady state, and after the interest shock, the real interest rate stays at its equilibrium level. Meanwhile, the investment tax credit is decreased at a constant rate from the initial level (at 1990q4) of 15 % to 0 by 1993q4. The economic agents anticipate the reduction of the tax credit after 1991q1.

In the simulation the real wage w_t/p_t start to fall at a constant, exogenous annual rate of 1 %. The decline continues until the end of the year 1994. After 1994q4 the economy starts a gradual return towards a state where the balanced trade condition holds, and the wage is governed by the labor supply $\overline{n}_t$. To achieve that, ξ_t is assumed to decrease from 1 to 0 at a constant pace of 0.01 units per quarter.[19]

[18] The interest rate shock is assumed to affect the world interest rate, while the exchange rate (ϵ_t) is fixed. The interest rate shock is calibrated based on the observed hike in the Finnish real interest rate. In the model with exogenous exports the exchange rate merely affects the share of the domestic good in the domestic final good. The domestic share stayed relatively stable during the crisis, and therefore the constant exchange rate is a reasonable assumption.

[19] In practice the benchmark model is solved using the more general model with additional financial features by setting the nominal share of durable (housing) consumption to a very small number (0.0005), and the share of credit constrained households to 0.

4.1.2 The additional shocks

The additional financial and tax shocks are also analyzed. The baseline model is extended to include credit constrained consumers and financial frictions. The additional adverse financial conditions are assumed to hit the economy at the same time with the first interest rate shock, 1991q4. Their sizes are calibrated based on Figure 2.3. The credit constrained consumption is forced to decline by 7.3 % of GDP ($s = 0.073$), and there is a 2 % increase in the financial friction at annual rate ($1 + f = 1.02^{0.25}$) that builds a wedge between the required return to the business and durable consumption (housing) capital, and the real interest rate. The financial shocks fade out gradually and disappear by the end of the year 1997. Furthermore, the social security contributions that amounts to 5 percent of total wages are introduced unexpectedly in the beginning of 1993. They are held constant until the year 1996 and then lifted during the year 1997.

4.2 Results

Figure 4 plots actual and simulated responses for key macroeconomic variables measured as percent deviations from the precollapse steady state. The actual responses are taken from Gorodnichenko et al. (2012) and they are measured as differences between the predictions based on observed trends in 1975-1990, and the actual developments of the variables during the crisis. In both cases the steady state in 1990 receives the value 0.

The simulated paths of the benchmark specification capture fairly well the persistent contraction in the investment dynamics during the crisis, although the contraction falls short on the cumulative deviation of the actual capital series from the imposed long-run trend. The contraction is accompanied by reasonable behavior of other variables, although their responses are also somewhat too muted. Value added, consumption, and employment fall an amount that meets roughly

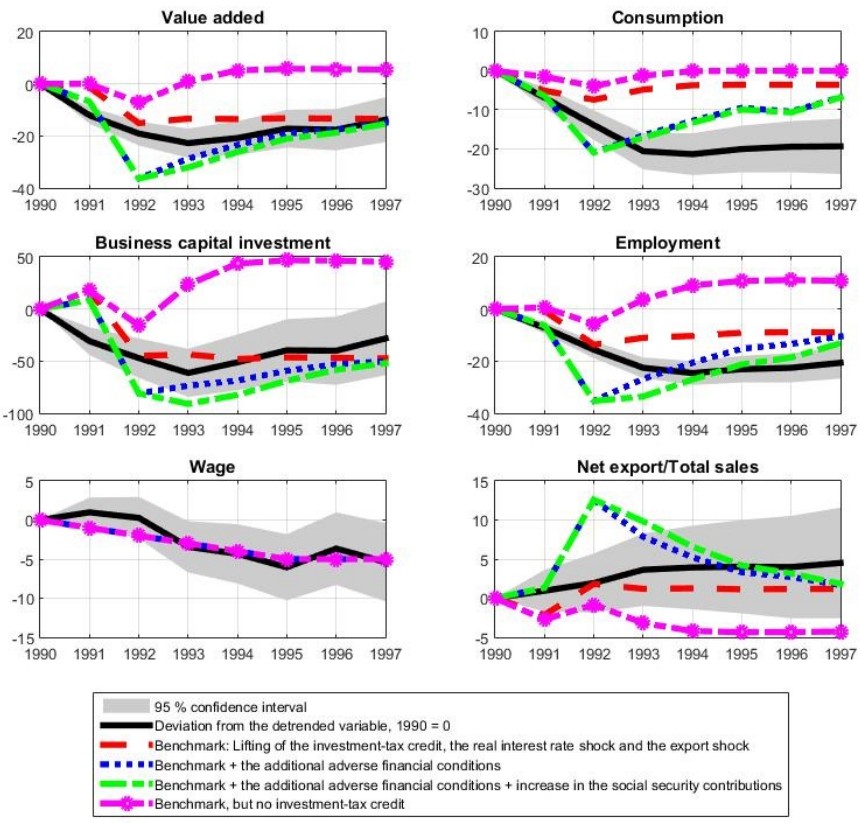

Figure 4: Quantitative results. Data: Deviation from the detrended variable, 1990 = 0 (black line); 95 % confidence interval (gray area). Simulated shocks: In 1990q1 the Soviet and the western export shocks decreases export demand by 10 %. There are two real interest rate shocks in 1991q4 and 1992q2 that come as a surprise and lift the real interest rates by 2 percentage points at quarterly rate (ar(1) = 0.9). The investment tax credit is decreased at a constant rate from the initial level (at 1990q4) of 15 % to 0 by 1993q4. The additional, surprise financial shocks hit the economy in 1991q4 and include a decrease in the credit constrained consumption (7.3 % of GDP) and financial friction (2 % of GDP at annual rate) that builds a wedge between the real interest rate and the return to the business and the durable consumption (housing) capital. They disappear by the year 1997. There is a surprise increase in the social security contributions in 1993q1 that amounts to 5 percent of gross wage that remains constant until 1997. The wage drops at an exogenous rate of 1 percent per year until the year 1995.

one half of the contraction during the crisis.

Although the magnitude of the collapse is not quantitatively correct, the simplest model (without the additional financial conditions and the social security contributions) can help in terms of understanding the mechanism. On the supply side the collapse of the economic activity stems from the lowering of the capital utilization rate and employment. There are several reasons for the lowered capital utilization rate. When the tax-credit is lifted, the tobin's q of capital starts to increase due to the expected increase in the cost of investment goods and the adjustment costs of the capital stock. Its increase means that the marginal productivity of capital must also increase to maintain the required return to capital, while the capital stock starts to shrink. To meet the fallen investment, export and consumption demand, as well as the required return to the effective capital stock, the capital utilization rate must also fall.

The decline in employment is at first due to the increase in involuntary unemployment. The fall in the capital utilization rate generates a downward push to the marginal return to labor, and to match the marginal return with the rigid wage level, the firms need to lay off workers. In the long run the contraction in employment reflects the fall in the real wage that leads into a permanent decline in the labor supply under constant disutility of work and the GHH preferences. Finally, consumption falls contemporaneously due to the increase in the real interest rate, while the effect has some persistence due to the fact that the decline in the capital stock have a permanent effect on the economy's production capacity.

It is illustrative to compare the baseline results to a scenario without the lifting of the investment-tax credit.[20] When the interest rate and the export shocks - a scenario that is closest to Gorodnichenko et al. (2012)[21] - are the only shocks

[20]The economy does not initially have the investment tax credit, and it stays at 0 during the whole simulation

[21]They argue that the interest rate shock followed the real economy, which can be rationalized if it assumed that the severe retrenchment in consumption and investment expenditures due

that hit the economy under the fixed adjustment rate of wages, they are able to generate a fall in the key variables. However, the fall remains short-lived, and turns into rapid increase of both investment and employment. In terms of value added consumption, and employment, the economic contraction remains quite small, roughly 5 %.[22] It is noteworthy that while this paper's model does not have the sectoral structure of Gorodnichenko et al. (2009, Figure 5), the results of the simulation without the investment-tax credit are in some respects very similar to their findings. Outside the Soviet sector the effect of the crisis is only small and transitory in terms of investments and employment. There is no fundamental force that would drive them down. Yet, the data clearly shows that the contraction in especially investments was persistent in all sectors of the economy.

Due to the additional shocks the responses for investment, production, consumption and employment are relatively close to the actual contractions. The responses are somewhat sharper than the data suggests arguably due to the perfect foresight assumption. The additional adverse financial conditions generate a further decline in consumption. Furthermore, the investments in business capital falls more by a considerable amount which further contributes to the crisis. The increase in the social security contributions has a more limited effect on the economy. It mainly shows up as a negative push to employment and a further decline in investments. It is noteworthy, that including the contributions as a more consumption-tax type of shock could have decreased consumption more in the long-run. Consistent with the data, the model predicts an increase in the net

only to the Soviet trade collapse could have caused a proportional collapse in demand for real balances, which under a fixed or managed exchange rate and a set level of foreign reserves, could have been large enough to trigger a currency crash.

[22]The shock remains short-lived because the only way that the model can be consistent with the decreasing wage in the medium term is when the disutility of work falls. The lowering wage and the increasing labor supply together generates profitable investment opportunities. This effect becomes less pronounced when the wages do not fall as much as in the data.

export-GDP ratio, but the increase is gradual in the data while in the model it peaks in 1992. This is a common feature with Gorodnichenko et al. (2012).

Selected other features of the simulations are reported in Figure 5. First, the model is consistent with the size of the cumulated fall in capital stock. In the model the capital stock falls by the end of 1997 by 16 percent while the actual fall is moderately larger, roughly 18 percent. Almost one half of the contraction is due to the lifting of the investment tax credit. [23]

In an earlier work, Conesa et al. (2007) study the crisis with an RBC model and finds that a multi-factor productivity shock (MFP) was the main driving force for the crisis. However, with their standard RBC model it is hard to explain why the MFP fell. In their methodology the lowered utilization rate of capital is accounted for as an MFP shock[24], and therefore the current model generates an endogenous MFP series. In the simulations the capital utilization rate falls sharply, and moderately more than the data suggests, while the total size of the MFP shock is of the right magnitude.

The extended model allows to analyze the implications of the financial shock in more detail. A comparison is made between the change in the volume of the residential housing investments relative to the trend before the 1990, and the model's deviation from the steady state in 1990. Again, the size of the investment collapse is of the right magnitude, but it seems that the model predicts a somewhat too sharp reaction to the economic conditions. On the other hand, the investment contraction is more persistent than the model's behavior that may partially explain the lack of persistence in the simulated total consumption path.

In the model capital adjustment costs are the key parameters that governs the inertia of investment shocks. One explanation for the sharp response is that

[23] It is also worth noticing that as a result of the removal of the investment-tax credit the relative price of investment increases by 15 percent between the steady states of the economy.

[24] the shock amounts to the contribution of the lowered utilization rate to output ($= 100 * (x_t^{1-\alpha} - 1)$ %)

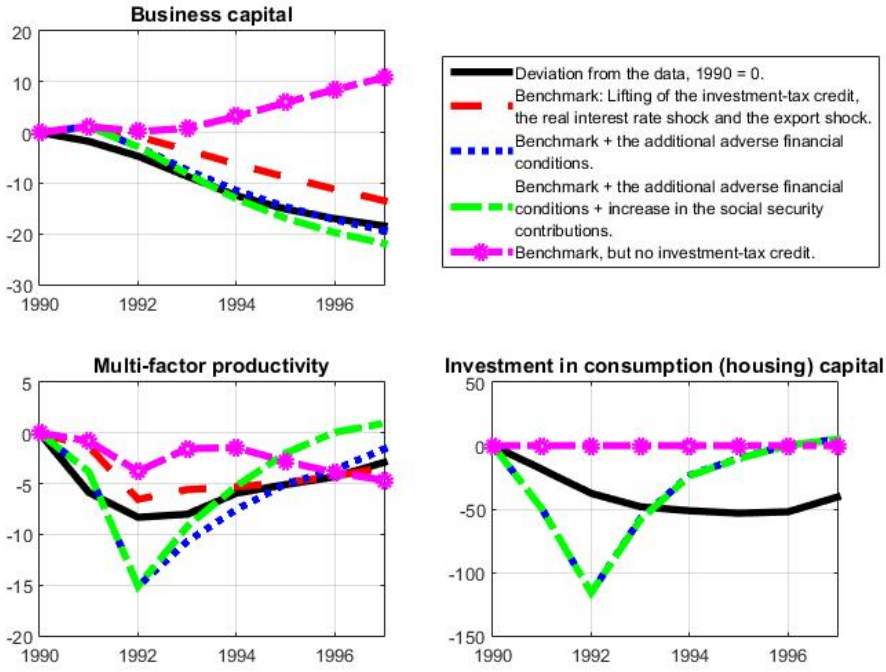

Figure 5: Additional results. Data: Percent deviation from the variable, 1990 = 0 (black line); Capital stock = detrended variable (1975-1990, log-linear trend) in Figure 1.4; Multi factor productivity = series constructed by Gorodnichenko et al. (2012); Investments in durable consumption (housing) capital = Volume of residential housing investment relative to trend (1975-1990, log-linear trend). Simulations: Deviation from the initial steady state in the specification.

	Value added		Employment		Investment		Consumption	
	1992	1997	1992	1997	1992	1997	1992	1997
The real interest rate shock and the export shock	20 %	0 %	16 %	0 %	19 %	0 %	19 %	0 %
Lifting of the investment-tax credit	22 %	88 %	23 %	69 %	36 %	91 %	17 %	53 %
The additional adverse financial conditions	59 %	10 %	61 %	12 %	45 %	6 %	65 %	46 %
The increase in the social security contributions	0 %	3 %	0 %	20 %	0 %	4 %	0 %	1 %
Total	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %

Table 1: Contributions of the different shocks to the total contraction of the economy

the calibrated values are too small. To see whether that is the case, a moderate increase in the cost parameters for both capital types is considered as a robustness check. In the Appendix it is shown that when the parameter value is increased from 8 to 13 which is still a reasonable value, the response is no longer too sharp, but instead too slow. This suggests that within a plausible interval of parameter values (8-13) the simulated economic contraction is close to the observed one.

Finally, Table 4.2 reports the contributions of different shocks to the total contraction of the key macroeconomic variables. Row 1 shows the percentage share of contraction when the shocks are the 10 % contraction in the volume of exports, and the real interest rate hikes, to the contraction when all shocks are considered. In this scenario some of the variables grow above the initial levels during the simulations in which case their contribution is set to 0 in the corresponding date. Row 2 reports the relative increase in the contraction when the investment-tax credit is also considered. Row 3 reports increase in the contraction when the additional adverse financial conditions are added, and row 4 reports the remaining effect of the increase in the social security contributions.

In general, the results are in line with Gulan et al. (2014) who uses a structural VAR model with sign and exogeneity restrictions to identify different shocks. They find that the collapse of the overheated financial and banking sectors was a key

contributing factor to the crisis, while the foreign shock could account for at most about half of the slump.[25] Furthermore, this paper's analysis confirms that the deleveraging and restructuring process of the financial system substantially prolonged the subsequent recovery.

Among other things the Table can give new insights on why the Swedish crisis was not as severe as in Finland although the financial conditions in both countries were quite similar. As Sweden was less 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 a sizable portion of the difference. [26] According to Gorodnichenko et al. (2012) the fall below trend in the Finnish value added was 21%, while it was 8% in Sweden. In this paper the overcapacity problem provides a roughly 5 percentage point larger contraction (of the total 13 percentage points), while the rest is due to the more severe other conditions.

5 Conclusions

This paper reconsiders the reasons for the Finnish Great Depression. The paper shows that Finland experienced institutional adjustments as well as financial and tax shocks that may have been larger than the previous literature suggests. It uses a general equilibrium model to show that they can together generate a large,

[25] A change of the cost parameter values have only a moderate effect on the contributions, for example the real interest rate and export shocks contribute to the crisis by the same amount despite the cost parameters are changed from 8 to 12, while the role of the lifting of the investment-tax credit changes from 23 % to 21.5 %.

[26] While Sweden (and many other countries, see, e.g., Eichengreen, 2007) resorted to a very similar investment-led growth policy after World War II, the country had abandoned the policy already in the 1970s. Figure 1.2 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.

widespread, and persistent fall in key macroeconomic variables without resorting to rather strong assumptions regarding sectorial labor movement, substitutability of energy, and consumption –as made by Gorodnichenko et al. (2012).

The analysis does not leave much room for a large, direct impact of the Soviet trade shock. Having said that, it should be emphasized that this paper remains agnostic over the exact causal relationship between the other shocks and the collapse of the Soviet Union. There are likely to be complementaries between the different shocks. It is likely that the Soviet trade helped to maintain the investment-led growth policy until the 1980s. It is most likely that the Soviet collapse and the accompanied interest rate shock generated a feeling of permanence that finally triggered the financial collapse of the already battered economy.

However, it is clear that the collapse of the investment-led growth policy and the financial crisis generated a far greater and more persistent shock than the trade shock alone could have produced. This part of the Finnish experience should be taken into account when it is used to quantify the effects of large trade shocks. Furthermore, the results suggest that the role of institutional transformations, even in a western democracy with developed capital markets and institutions like Finland, may have been large. This should be remembered, when the Finnish example is used to isolate collapse of trade with the Soviet Union from the other burdens of adjustment borne by other transitional economies.

References

[1] Acemoglu, D., Aghion, P., Zilibotti, F. (2006) Distance to Frontier, Selection, and Economic Growth. Journal of the European Economic Association, MIT Press, vol. 4(1), pp. 37–74, 03.

[2] Conesa, J. C., Kehoe, T. J., Ruhl, K. J. (2007) Modeling great depressions:

the depression in Finland in the 1990s. Quarterly Review, Federal Reserve Bank of Minneapolis, issue Nov, pp. 16–44.

[3] Eaton, J., Kortum, S. (2002) Technology, Geography, and Trade. Econometrica, Econometric Society, vol. 70(5), pp. 1741–1779, September.

[4] Eichengreen, B. (ed.) (2007) Europe's Postwar Recovery. Cambridge Books, Cambridge University Press, number 9780521030786, October.

[5] Freystätter, H. (2011) Financial factors in the boom-bust episode in Finland in the late 1980s and early 1990s. BoF DP 1/2011.

[6] Gorodnichenko, Y., Mendoza, E. G., Tesar, L. L. (2012) The Finnish Great Depression: From Russia with Love. American Economic Review.

[7] Gorodnichenko, Y., Mendoza, E. G., Tesar, L. L. (2009) The Finnish Great Depression: From Russia with Love. NBER Working Papers 14874, National Bureau of Economic Research, Inc.

[8] Greenwood, J., Hercowitz, Z., Huffman, GW. (1988) Investment, Capacity Utilization, and the Real Business Cycle. American Economic Review, vol. 78(3), pp 402-17, June.

[9] Gulan, A., Haavio, M., Kilponen, J. (2014) Kiss me deadly: From Finnish great depression to great recession. Bank of Finland Discussion Paper 24.

[10] Hall, R. E. (2011) The Long Slump. American Economic Review, 101(2): 431–69.

[11] Heikkinen, S., Kuusterä, A. (2001) Finnish Economic Crises in the 20th Century. In: Kalela J, Kiander J, Kivikuru U, Loikkanen HA, Simpura J. (Eds.), Down from the heavens, up from the ashes. The Finnish economic crisis of

the 1990s in the light of economic and social research. Government Institute for Economic Research, Publications 27:6.

[12] Honkapohja, S., Koskela, E. (1999) The economic crisis of the 1990s in Finland. Econ Policy 14: pp. 399–436.

[13] Honkapohja, S., Koskela, E. A., Leibfritz, W., Uusitalo, R. (2009) Economic Prosperity Recaptured: The Finnish Path from Crisis to Rapid Growth. MIT Press Books, The MIT Press, edition 1, volume 1, number 0262012693, June.

[14] Jonung, L., Kiander, J., Vartia, P. (2008) The great financial crisis in Finland and Sweden – The dynamics of boom, bust and recovery, 1985–2000. European Economy – Economic Papers 350.

[15] Kalela, J., Kiander, J., Kivikuru, U., Loikkanen, H. A., Simpura, J. (Ed.) (2001) Down from the heavens, up from the ashes. The Finnish economic crisis of the 1990s in the light of economic and social research. Government Institute for Economic Research, Publications 27:6.

[16] Kari, S., Rauhanen, T., Kröger, O., Junka, T., Myhrman R., Koskenkylä H. (1995) Finnish Corporate Tax Reforms. VATT Publications 20

[17] Korkman, S. (1992) Exchange Rate Policy and Employment in Small Open Economies. In: Pekkarinen, J., Pohjola, M., Rowthorn, B. (Eds.), Social Corporatism. A Superior Economic System? Wider Studies in Development Economics, Clarendon Press, Oxford.

[18] Pietilainen, S. (2010) The Bayesian Estimation of Private Investment in Finland. The Finnish Ministry of Finance. Discussion papers 1/2010

[19] Landesmann, S. (1992) Industrial Policies and Corporatism. In: Pekkarinen, J., Pohjola, M., Rowthorn, B. (Eds.), Social Corporatism. A Superior Eco-

nomic System? Wider Studies in Development Economics, Clarendon Press, Oxford.

[20] Pohjola, M. (1996) Tehoton Pääoma – Uusi näkökulma taloutemme ongelmiin. WSOY.

[21] Song, Z., Storesletten, K., Zilibotti, F. (2011) Growing Like China. American Economic Review, American Economic Association, vol. 101(1), pp. 196–233, February.

Appendix A. Measuring the Size of the Investment-tax Credit

In this Appendix size of the reserves is measured and compared to the value of the total investments to estimate the rate at which investments are supported. The next Table collects definitions and parameter values. The definitions and values of effective tax rates are taken from Kari et al. (1995, section 4, table 4.1), while capital income and nominal investment shares are based on the estimates of the Statistics Finland.

Parameter	Description	1989	80-89 ave.
TR^1_{eff}	Eff. tax rate with reserves (TR_{leg} -ATR1-ATR2)	0.142	0.171
TR^2_{eff}	Eff. tax rate without reserves (TR_{leg} -ATR1)	0.204	0.291
TR_{leg}	Statutory tax rate	0.5	0.56
CAP	Cap. income (private sector) = VA - Labor cost	.	.
CAPs	Cap. income share (private sector) = $\frac{CAP}{pY}$	0.302	0.302
DD_{inv}	Investment reserves	.	.
DD_{oth}	Other tax deductions	.	.
TAX_{icred}	Investment tax credit	.	.
TAX_{corp}	Total corporate taxes	.	.
INV	Nominal investments	.	.
INVs	Nominal investments over GDP	0.29	0.26
τ	TC / Nominal investments	?	?

To quantify τ, let us first note that the effective tax rate without investment tax credit is the ratio of total corporate taxes, and the sum of the capital income and the other deductions (the effect of the difference between accounting earnings and taxable income) that the corporation aqcuires during the year:

$$TR^2_{eff} = \frac{TAX_{corp}}{CAP + DD_{oth}} \tag{27}$$

After using the definition of statutory tax rate ($TR_{leg} = \frac{TAX_{corp}}{CAP}$), the effective tax rate becomes

$$TR^2_{eff} = \frac{TR_{leg} CAP}{CAP + DD_{oth}} \tag{28}$$

Therefore, the sum of the capital income and the other deductions becomes

$$CAP + DD_{oth} = \frac{TR_{leg}}{TR^2_{eff}} CAP \tag{29}$$

If information on the effective tax rate with the reserves ($TR^1_{eff} = \frac{TR_{leg}CAP}{CAP+DD_{oth}+DD_{res}}$) is also available, the investment tax credit ($TR^1_{eff}DD_{res}$) can then be solved after rearranging the expression for TR^1_{eff} :

$$\begin{aligned} TR^1_{eff}CAP &= TR_{leg}CAP - TR^1_{eff}DD_{res} - TR^1_{eff}DD_{oth} \Leftrightarrow & (30)\\ TR^1_{eff}DD_{res} &= TR_{leg}CAP - TR^1_{eff}(CAP + DD_{oth}) & (31)\\ &= TR_{leg}CAP - TR^1_{eff}\frac{TR_{leg}}{TR^2_{eff}}CAP & (32)\\ &= (TR_{leg} - TR^1_{eff}\frac{TR_{leg}}{TR^2_{eff}})CAP & (33) \end{aligned}$$

Finally, the rate at which investment are subsidized can be solved:

$$\tau = \frac{TR^1_{eff}DD_{inv}}{INV} = \frac{(TR_{leg} - TR^1_{eff}\frac{TR_{leg}}{TR^2_{eff}})CAPs}{INVs} \quad (34)$$

Meanwhile, the effective corporate tax rate is TR^2_{eff} before the reform and falls to TR^1_{eff} after the reform.

After plucking in the parameters for the year 1989, τ is found to be 15.8%.[27] The average over the years 1980-1989 is 17.7%.

Appendix B: Alternative values of the adjustment cost parameters

Figures (6) and (7) show the results of the simulations when the adjustment cost parameter values for both business capital and durable consumption (housing) capital are changed from 8 to 13.

[27] It is noticeable that the estimated size of the tax subsidy depends on how broad effective tax rate is used in the comparison. If the 1989 broadest effective tax rate (10.1%) in Kari et al. (1995, Table 4.1) is used, the estimated subsidy is roughly 19%.

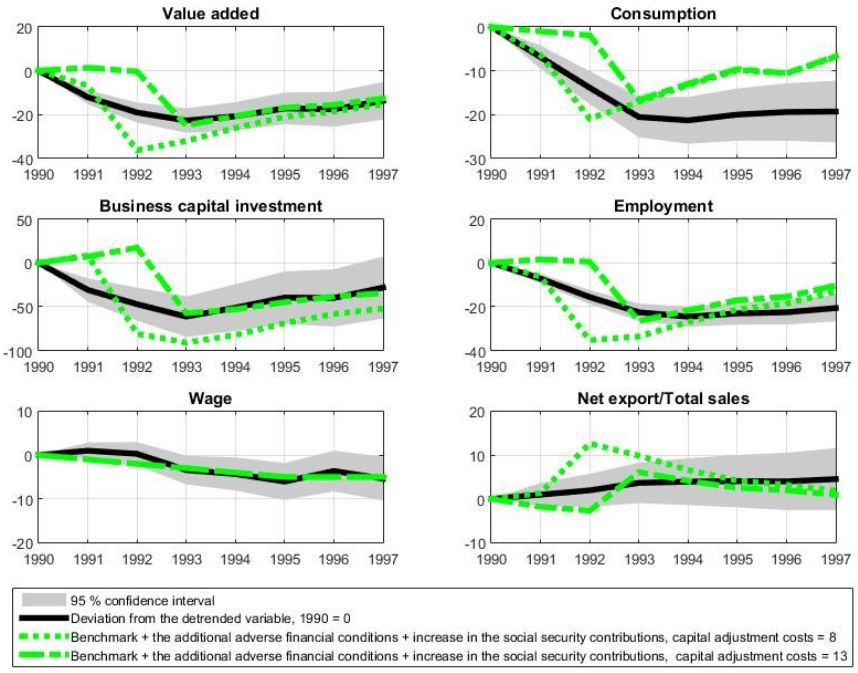

Figure 6: Quantitative results. Data: Deviation from the detrended variable, 1990 = 0 (black line); 95 % confidence interval (gray area). Simulated shocks: In 1990q1 the Soviet and the western export shocks decreases export demand by 10 %. There are two real interest rate shocks in 1991q4 and 1992q2 that come as a surprise and lift the real interest rates by 2 percentage points at quarterly rate (ar(1) = 0.9). The investment tax credit is decreased at a constant rate from the initial level (at 1990q4) of 15 % to 0 by 1993q4. The additional, surprise financial shocks hit the economy in 1991q4 and include a decrease in the credit constrained consumption (7.3 % of GDP) and financial friction (2 % of GDP at annual rate) that builds a wedge between the real interest rate and the return to the business and the durable consumption (housing) capital. They disappear by the year 1997. There is a surprise increase in the social security contributions in 1993q1 that amounts to 5 percent of gross wage that remains constant until 1997. The wage drops at an exogenous rate of 1 percent per year until the year 1995.

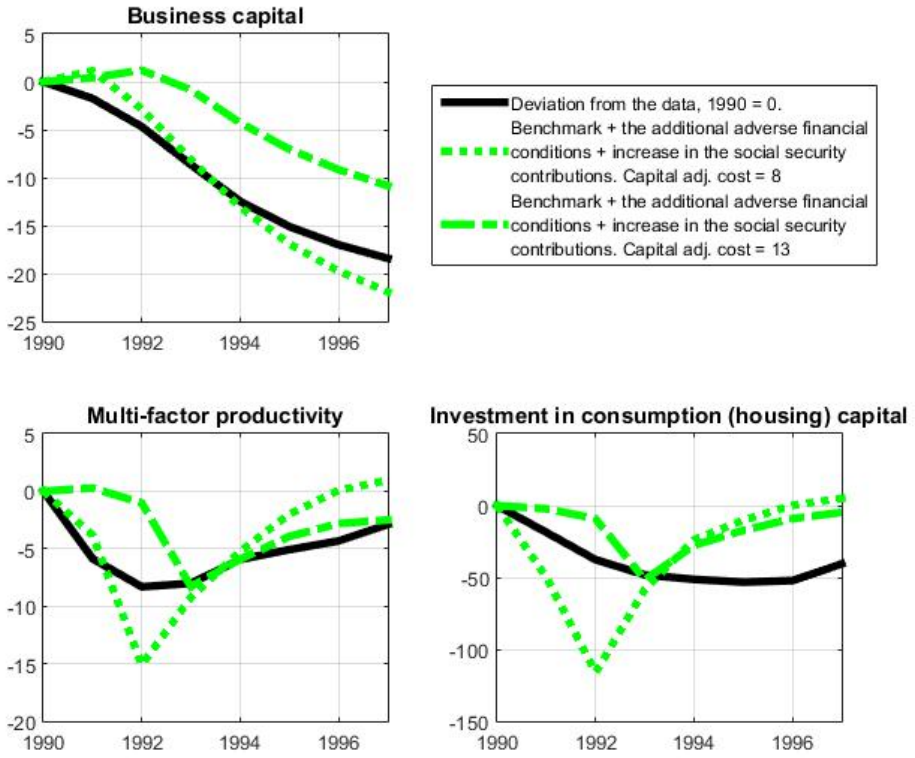

Figure 7: Additional results. Data: Percent deviation from the variable, 1990 = 0 (black line); Capital stock = detrended variable (1975-1990, log-linear trend) in Figure 1.4; Multi factor productivity = series constructed by Gorodnichenko et al. (2012); Investments in durable consumption (housing) capital = Volume of residential housing investment relative to trend (1975-1990, log-linear trend). Simulations: Deviation from the initial steady state in the specification.

Table 2: Data sources

Variable	Source
Business capital investments, trend, and CI	Gorodnichenko et al. (2012)
Consumption durables (value)	OECD: P31CP042 + P311B
Consumption, trend, and CI	Gorodnichenko et al. (2012)
Deposit bank spread	IMF (FR.INR.LNDP)
EK survey data	ETLA database
Employment, trend, and CI	Gorodnichenko et al. (2012)
Household debt burden	The Finnish National accounts
Income tax and ss. contributions	OECD (Taxing Wages 1998-1999)
Industry-level investment shares	The Finnish National accounts
Long-term government interest rate	OECD country tables
Net exports / total sales, trend, and CI	Gorodnichenko et al. (2012)
Nominal investment share	Penn World Table 7.2 (ci)
Non-residential capital stock	Stat. Finland, M. Pohjola
Real interest rate (6 mth Helibor - CPI)	Gorodnichenko et al. (2012)
Relative price of investments	Penn World Table 7.2 (pi/pc)
Residential housing investments (volume)	The Finnish National Accounts
Value added, trend, and CI	Gorodnichenko et al. (2012)

Appendix C. Data sources