THE FINNISH GREAT DEPRESSION: FROM RUSSIA WITH LOVE

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Abstract

During the period 1991-93, Finland experienced the deepest economic downturn in an industrialized country since the 1930s. We argue that the collapse of the Finnish trade with the Soviet Union in and of itself resulted in a large contraction of the economy and a costly restructuring of the manufacturing sector, similar to the transition suffered by countries in Eastern Europe. Interestingly, Finland and transition countries experience almost identical “U-shaped” dynamics of output in the early 1990s. Finland experienced the full force of the Soviet trade shock, but as a western democracy with fully developed capital markets and a well-functioning legal and political system, faced none of the institutional adjustments experienced in the formerly centrally-planned economies. Thus, by studying the Finnish experience it is possible to separate the adjustment costs due to the collapse of trade from the other burdens of adjustment borne by transition economies. Importantly, unlike previous analyses of depressions, we have an exogenous shock with known timing. We develop and calibrate a multi-sector model of the Finnish economy and show that the collapse of Soviet-Finnish trade can indeed explain a bulk of the recession in Finland.

JEL: E32, F41, P2.

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I Introduction

During the period 1991-93, Finland experienced the deepest economic downturn in an industrialized country since the 1930s. As illustrated in Figure 1, between 1990 and 1993 Finnish real GDP declined thirteen percent, real consumption declined seven percent and investment fell to 45 percent of its 1990 level. Over the same period, Finland experienced a quadrupling of unemployment from slightly under 4 percent to a peak of 18.5 percent and the stock market lost 60 percent of its value.

The crisis in Finland has been attributed to a number of factors. One view is that Finland experienced a twin financial-cum-exchange-rate crisis that was shortly to be repeated throughout Asia and Latin America (Bris and Koskinen 2000, Honkapohja and Koskela 1999, Honkapohja et al 1996, Vihriala 1997). Under this scenario, increased financial liberalization during the 1980s resulted in an over-expansion of credit, an over-valued stock market, inflated real estate values and a large stock of debt. A downturn in the economy in the early 1990s due to the loss of the Soviet export market and a slowdown in European growth triggered both a speculative attack on the exchange rate and a credit crunch, requiring an estimated bailout of the financial sector of 10 percent of GDP. Thus, a negative shock that would have been manageable in normal circumstances through prudent fiscal and monetary policy took on crisis proportions. An alternative explanation for the depression is that the collapse of trade with the Soviet Union in and of itself resulted in a large contraction of the economy and a costly restructuring of the manufacturing sector, similar to the transition suffered by countries in Eastern Europe. The barter-type arrangement skewed Finnish production toward particular labor-intensive sectors and effectively allowed Finland to exchange non-competitive, labor-intensive products for energy imports at an overvalued exchange rate.

The impact of the trade shock on Finland is interesting in its own right, but it is especially compelling in light of the similar experiences of economic contraction and restructuring in the transition economies in Eastern Europe. Figure 2 plots the paths of real GDP in the Czech Republic, Hungary, Poland, Slovenia, Slovak Republic and Finland. Three observations stand out from the data. First, the figure captures the familiar “U-shaped” path for output characteristic of transition economies (Blanchard and Kremer 1997). In all of the economies in Figure 2 with the exception of Poland, output declined between 1990 and 1993 and the magnitude of the cumulated output drop ranged from roughly 12 to 22 percent of the level of GDP in 1990. Second, with the exception of Poland, output growth became positive in 1994. By 1996 Slovenia,
the Czech Republic and Finland returned to their 1990 level of real GDP. A number of papers have explored the possible impact of trade on output in transition economies. Shortly after the dismantling of the Soviet Union, Rodrik (1992, 1994) estimated that the collapse of trade with the USSR could account for a 7 to 8 percent decline in GDP in Hungary and Czechoslovakia and a 3.5 percent decline in Poland. At the time the papers were written, it was too early to characterize the transition path and U-shaped pattern of output resulting from the loss of trade, but Rodrik's work suggested that trade was a key factor in understanding the dramatic decline in output in 1990 and 1991. Finally, the most remarkable feature of the figure is that the adjustment path for Finnish GDP in the post-1990 period is virtually identical to the transition paths of the countries in Eastern Europe. Finland experienced the full force of the Soviet trade shock, but as a western democracy with fully developed capital markets and a well-functioning legal and political system, faced none of the institutional adjustments experienced in the formerly centrally-planned economies. Thus, by studying the Finnish experience it is possible to separate the adjustment costs due to the collapse of trade from the other burdens of adjustment borne by transition economies.

In the next section of the paper we describe Finland's trading relationship with the USSR and the nature of the institutional arrangements that facilitated trade between the USSR and Finland. We will argue that these arrangements caused Finland to specialize in sectors that were inefficient from an economic point of view. The paper presents some alternative measures of the economic cost of the collapse of Soviet trade on impact. Following the methodology outlined in Oblath and Tarr (1991), Tarr (1994) and Rodrik (1994), we show that the collapse of the trading arrangement with the USSR resulted in a dramatic deterioration in Finland's terms of trade and a significant output reduction. This estimate understates the full impact of the loss in trade as it does not measure the sectoral adjustment costs or the full effects of the increase in the price of energy.

In Section III, we develop a dynamic multisector model designed to capture the basic features of Finland's production and trade with the rest of the world. The model is calibrated using data before the collapse of Soviet trade. Then we hit the model economy with the shocks corresponding to the collapse of the Soviet Union and compare the model impulse response with the dynamics of the corresponding variables in the data. By comparing model and data series, we investigate how much of the output dynamics in Finland and, by extension, transition economies can be explained by the “pure trade shock” and how much may be explained by other factors. To the extent the real model falls short of explaining the depression, one may need to incorporate
alternative explanations such as for example a crisis in the financial sector. Thus one of the goals of the paper is to explore the role of financial sector as a source of financial vulnerability and as a mechanism for propagating the crisis.

In section IV, we compare trade theory of the Finnish recession with alternative explanations. In section V, we compare the Finnish experience with the experience of the transition countries (and in particular countries of the former Council for Mutual Economic Assistance, CMEA) and discuss how our conclusion for Finland can be extended to former Soviet block countries. We make concluding remarks in Section VI.

II The Finnish-Soviet Trade and Depression

Finnish-Soviet Trade

Prior to the dissolution of the Soviet Union, the trade between the USSR and Finland was conducted on a bilateral basis and was regulated by a series of five-year agreements that determined the volume and composition of trade between the two countries. The two countries also agreed to a system of clearing accounts denominated in rubles to finance the flow of trade. The accounts were maintained by the Soviet Foreign Trading Bank and the Bank of Finland. In principle, trade was to be balanced on an annual basis, though arrangements were periodically made to allow one of the parties to accumulate a temporary surplus. The trade imbalances were then taken into account in annual interim negotiations and were usually cleared on the Finnish side through supplemental exports exceeding previously agreed-upon quotas or on the Soviet side by additional petroleum exports.

Trade with the USSR expanded from the inauguration of the first five-year agreement in 1950 through the mid-1980s. By 1975, the USSR was Finland’s most important trading partner. Figure 3 plots the dynamics of the Soviet and non-Soviet exports over the 1975-2003 period. During the early to mid-1980s, the USSR accounted for 20-25 percent of Finnish trade flows and began to gradually decline thereafter until the cancellation of the bilateral agreement in December 1990. Over the forty years of trade between the two countries, the structure of trade effectively evolved into the exchange of energy imports for manufacturing exports at an overvalued ruble/dollar rate. In the 1960s Finland established a national oil refinery, Neste Oy,

1 See Mottola, Bykov and Korolev (1983) and Oblath and Pete (1990) for a more complete discussion of the history of trade relations between the USSR and Finland and the bilateral clearing system.
which processed imports of crude oil from the USSR to meet Finnish energy needs and in some years, to export to third markets. As shown in Figure 4, roughly 80 percent of Finnish imports from the USSR in the early 1980s were in the form of mineral oils, which accounted for between 60 to 85 percent of all energy imports into Finland. Under the terms of the bilateral agreement, the value of crude oil exports to Finland was determined by the dollar price of crude oil on the world market and then converted to rubles using the official ruble/dollar exchange rate. From the Finnish perspective, the volume of bilateral trade was thus a function of Finnish oil import demand given the world price of oil. During the oil crises of the 1970s, the oil-for-manufactures structure of trade provided Finland with a buffer against the cyclical fluctuations in employment and output that was experienced in most other industrialized countries. As oil prices rose, Finland was able to expand employment and production to finance the higher cost of energy imports. The downside of this arrangement, however, was ultimately realized with the collapse of trade in the 1990s – Finland faced both the loss of key export markets and the increase in the effective price of energy.

On the export side, the five-year trade agreements established explicit quotas for the export of manufactured products to the USSR. Some of the quotas took the form of long-term, multi-year contracts, such as the manufacture and export of ships to the USSR. While the total volume of exports was established by the bilateral trade agreement, the specific quantities and unit prices of the items to be exported was established through direct negotiations between Soviet officials and representatives of Finnish firms. Typically, firms in key industries would join trade federations and associations. The trade associations would conduct the negotiations, apply for export licenses from the Finnish government, and distribute the rights to export among their members. A key condition of the export license was an 80 percent domestic content restriction. The majority of exports to the USSR took the form of manufactured goods and machinery and transport equipment, which included the production of ships.

It was widely perceived that exporting to the USSR was a lucrative business for Finnish firms and Finland ran a persistent tradable-ruble surplus in its clearing account. The official rate for the ruble was overvalued, overstating the true value of Finnish exports. Given that industries negotiated both the price and quantity of the goods exported to the USSR, it need not have been

2 Finland also traded with other CMEA countries. However, the bulk of this trade was with the USSR, although in some years the bilateral agreements were modified to include the export of Finnish goods to other CMEA member countries.

3 For a discussion of the trading system of Hungary, Austria, Finland and Yugoslavia with the Soviet Union see the chapters by Richter (1990) and by Oblath and Pete (1990).
the case that an overvalued exchange rate would lead to overvalued Finnish exports. However, Finnish exports to the USSR were typically specialized for the Soviet market and did not compete directly with products traded in western markets. Based on commodity data at the seven-digit level, Kajaste (1992) estimated that the price level of exports to the Soviet Union was at least 9.5 percent higher than the price level of exports to western markets. We find an even larger markup when we replicate Kajaste’s analysis using more recent trade data at 5-digit disaggregation for 1990. Specifically, if we apply unit prices of non-CMEA exports to quantities of Soviet exports, we find that Soviet exports evaluated at non-CMEA export prices are 36% smaller than the value of Soviet exports. In other words, prices of goods exported to the USSR were on average 36% higher than prices of very similar goods exported to non-CMEA countries. Alternatively, one may interpret this markup as suggesting that if a Finnish industry redirected its Soviet trade to other countries, its goods would be competitive outside CMEA only if sold at the 36% discount.

In addition to the significant markup in the Soviet trade, pre-commitment to the five-year contracts eliminated much if not all of the exchange rate and business cycle risk typically faced by exporting firms. Surveys of Finnish producers reveal that exports to the USSR were viewed as “more profitable” than exports to other markets (Richter 1990). In another survey of industry experts the respondents indicated that Soviet trade was a relatively low risk, low cost, and long-term business although it had the disadvantages of requiring extra resources for determining prices, gaining market access and dealing with the Soviet and Finnish bureaucracies (Kajaste 1992, Sutela 2007). In the survey of the structural effects of Soviet trade on the Finnish economy, Kajaste (1992, p. 29) concludes that in the 1980s, “production emerged which was more and more specialized for Soviet trade [and that t]hese exports seem to have been exceptionally profitable… [I]n certain sectors firms which had lost their competitiveness in western markets started to concentrate on Soviet trade instead.”

To assess the degree of specialization, Kajaste (1992) computes the share of Soviet exports at 4-digit level of CCCN classification and finds strong concentration of trade. Once a good was exported to the East, more than 80% of all exports of this good went to socialist countries. At the more detailed 7-digit level, Kajaste (1992) identifies 133 items with the Soviet export share exceeding 90%. These items constituted approximately 40% of exports to the USSR. Kajaste (1992) reports that because of highly specialized nature of goods traded with the CMEA block, the collapse of trade with the Eastern markets was compensated only to a very
limited extent by redirecting trade to the West. The extent of specialization was such that capacity developed to trade with the USSR became more or less obsolete overnight.\(^4\)

Another important aspect of the trade with the USSR was concentration. Only 600 or so firms exported to the USSR in the 1970s, while more than 3,000 firms exported to Sweden (Sutela 1991). In 1989 the total number of Finnish exporters to the USSR was 1,688. The five largest exporters accounted for 39.9% of all exports, the fifty largest for 78.7%, 116 largest for 90% (Sutela 2005). This concentration of the Finnish-Soviet trade resembles trade within CMEA. Given this concentration, economies of scale were often cited as an important source of profitability in the Finnish-Soviet trade. The scale of production also often implies that firms are likely to be multi-product. In fact, one of the Finnish policies was to keep share of trade with any partner below 20% (Sutela 2005, 2007).

There was an important political component in the Finnish-Soviet trade. Political leaders in Finland and the USSR viewed trade as a guarantee of peaceful co-existence. For example, Urho Kekkonen, the Finnish prime minister and president for three decades, wrote in 1974, “…our whole stable foreign policy course demands that we do keep the Soviet markets.”\(^5\) Soviet leaders viewed the trade no only as a source of modern Western technology but also as a laboratory for cooperation between capitalist and socialist countries.

To give the reader a sense of how industries trading with the USSR responded to the loss of their major market, we present the dynamics of Soviet and non-Soviet exports for selected industries (Cable and wire; Railroad equipments; Shipbuilding; Footwear) in Figure 5. The striking feature across industries is that Soviet export was barely redirected to other countries. In other words, the loss of the Soviet market was not compensated by gains in other foreign markets. The example of the railroad equipment industry is particularly illuminating. Soviet Union and Finland had similar railroad systems which were different from the systems operated in other European countries. Locomotives and cars produced for the USSR would not fit the European system and, thus, exports to the USSR could not have been redirected to other

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\(^4\) The fact that Finnish exports to the USSR could have had a limited success in the West was clearly comprehended. Urho Kekkonen, President of the Republic and a very active promoter of trade and economic cooperation with the Soviet Union, wrote in a private letter on 20 November 1972: “We must of necessity maintain a relatively large trade with the West, but of much importance is the fact that we are able to sell to the Soviet market in the main such goods that would be very difficult to market into the West.” Cited in Sutela (2005).

\(^5\) Cited in Sutela (2007). It is often emphasized that the role of Kekkonen in developing Eastern trade was pivotal. A former leader of Soviet intelligence in Finland once wrote, “One can go to any lengths in thinking, whether Kekkonen was a Soviet ‘agent of influence’, but hardly anybody denies that the Finns had a president who pumped enormous amounts of economic benefit from Soviet leaders against short-term political concessions … and thus Finnish standards of living increased” (cited in Sutela 2007).
countries. Even for industries that had some export recovery (e.g., shipbuilding), the loss of the Soviet market was painful as they had to go through major transformations in product lines.\footnote{Sutela (1991) provides an illuminating case study of the shipbuilding industry in Finland. Finnish shipbuilders were supplying the Soviet Union since 1940s. The major companies were Valmet (state-owned), Repola, Wartsila, and Hollming. Only for Hollming the main activity was shipbuilding. Other companies were large corporations with a broad nomenclature of products. Historically shipyards fared well in terms of profits and accumulated a unique know-how in the industry. For example, most icebreakers operating in the world were produced in Finland. With the collapse of the Soviet Union, the shipyards were in deep trouble. Policymakers and business circles were openly discussing whether Soviets would allow these companies to go bankrupt. Valmet’s shipbuilding operations were sold to Wartsila, which knowingly took orders for loss-making luxury cruises (another field of specialization) for the Caribbean, underestimated domestic cost increases and declared its shipbuilding branch insolvent. The new company established upon the ruins of Wartsila-Marine was later sold to a Norwegian company.}

**Static Cost of the Collapse**

To assess the impact of the collapse of trade on the Finnish economy, one needs to consider the volume of trade, the relative price of exports to imports and whether or not the collapse was anticipated or not. Based on the declining share of Soviet trade illustrated in Figure 3, one might conclude that Finnish producers had ample warning of the impending loss of the Soviet export market, which would minimize the impact of the shock and help ease the transition. In our view, this is a misreading of the evidence. During the early to mid-1980s the decline in trade with the USSR can be attributed to the declining price of crude oil. Under the terms of the bilateral agreement, Finnish exports were required to roughly match the value of imports. Finnish production of export goods declined accordingly, and some firms had begun to export to the USSR outside of the bilateral agreement in 1989. However, in July 1990 the Wall Street Journal reported that Finnish Premier Harri Holkeri was surprised by the announcement that the Soviet Union would end the bilateral agreement early. A representative of the central bank suggested that it was still possible that the system would be reformed, and not fully dismantled.

One may get a rough estimate of the measure of the impact of the loss in trade by noting that goods produced for Soviet trade accounted for 4 percent of Finnish GDP. In one sense this estimate is an overstatement of the impact of the trade shock, since Finland could presumably substitute toward Western markets. However, it is more likely that this is an underestimate. First, the terms of trade are distorted – selling overvalued (and non-competitive) exports in exchange for energy. Second, underestimates the impact of a change in energy prices on the overall economy. Third, Finland had accumulated ruble surpluses which could not be redeemed for real goods and services.

To get a sense of the quantitative importance of losing trade with the USSR, we follow Rodrik (1994) in estimating the impact of loss of trade. Panel A in Table 1 calculates the terms
of trade effect, loss of market effect, removal of subsidy effect and the value of the loss or default on the cumulated ruble surpluses. Based on a 36 percent markup of Finnish export goods loss of trade accounts for 1 percent of 1990 GDP. Using a 50 percent markup as Rodrik and other author’s assume, we find that the loss was 1.3 percent without lost ruble reserves and 2.8% with lost ruble reserves.

Panel B in Table 1 compares Finnish estimates with Rodrik’s estimates for Hungary, Poland, Czech Republic. We can see that the US dollar amount for these transition countries and Finland is similar. This means that the loss of trade effect for Finland was of the same order of magnitude (in levels) as in other transition economies. However, the percent of GDP is smaller for Finland because Finland is a larger economy (at least in terms of market-measured output).

To provide some idea of the magnitude of the losses over time, Table 2 shows the gross value of product, hours and exports of manufacturing sectors in 1988, prior to the collapse of trade. The table also shows the volume of exports to CMEA countries (primarily the USSR), and the value of exports as a share of total product. Note that two sectors, Textiles, Apparel & Leather and Machinery & Transport Equipment, were especially exposed to Soviet trade. Both had high ratios of sector exports relative to sector value added (34 and 72 percent) respectively, and nearly a third of all of their exports were sent to the CMEA. While CMEA exports accounted for about 6 percent of Finnish manufacturing output, 11 and 20 percent of the value added of those two sectors was exported to the CMEA. Those two sectors were also relatively labor intensive, with hours to value added ratios of 5.5 and 2.6. The bottom of Table 2 shows the change in output and hours in each manufacturing sector over 1988-93. Value added in textiles declined nearly 40 percent in nominal terms, and output in machinery and transport equipment declined 1 percent (furniture was the other sector to decline in nominal terms, but it accounted for only a small fraction of aggregate output in 1988). Finally, note that while hours contracted in all sectors, the contraction in the two CMEA exporting sectors declined the most dramatically. In summary, the two manufacturing sectors that suffered the largest contraction were those the most exposed to CMEA trade.

All of these estimates are likely to be underestimates because they ignore the dynamic adjustment that must take place in response to the loss in trade. For example, Rodrik (1994) argues that inflexible prices could lead to large Keynesian-type multipliers to trade shocks. In the

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7 The fact that USSR bought textiles from Finland looks less puzzling when one takes into account that for political reasons the USSR could not trade with those countries whose textile industry was dominating the rest of the world (see Sutela 1992).
next subsection we briefly describe labor markets in Finland and argue that wage rigidity could have been an important determinant of the depression depth.

**Labor Markets**
Similar to Scandinavian countries, Finnish labor market is characterized by almost complete unionization. In 1993, approximately 85 percent of workers belonged to unions and almost 95 percent of workers were covered by collective agreements (Böckerman and Uusitalo, 2006). Since most employers are organized in federations, the wage bargaining normally starts at the national level. If a nation-wide agreement is reached, each federation and union decides if this agreement is acceptable. If the nation-wide agreement is found satisfactory, the wage bargaining process is completed. If a federation or union rejects the nation-wide agreement, it can negotiate its own terms. Collective agreements stipulate the wage tariffs for different levels of job complexity, education, etc. in a given industry. Typically, agreements allow upward wage drift if firms perform well. Although the government does not have a formal role in the bargaining process, the government usually intermediates negotiations.\(^8\) Not surprisingly, Finland is often classified as a country with highly centralized wage setting (e.g., Botero et al 2004).

Table 3 provides a summary of wage agreements in the 1990s. Note that in 1992-1993, which were the peak years of the depression, unions did not agree to cut nominal wages. Instead, the wages were frozen at the 1991 level. Figure 6 reports the distribution of wage changes over 1990-1995 for individual workers. There is a clear spike at zero percent change for most types of workers in 1992 and 1993.\(^9\) Strikingly, the fraction of workers with no wage change reached 75%. Thus, the national agreement was binding for a broad array of firms and workers. Given that inflation was quite moderate in the 1990s, real wages fell only to a limited extent. These findings are consistent with Dickens et al (2007) reporting that Finland is the country with one of the greatest downward wage rigidities.

As we will report later, the dynamics of wages at the macro level is similar to the dynamics of wages at the micro level. Specifically, wages at the aggregate level had a very weak downward adjustment during the depression. Our micro level evidence strongly suggests that very sluggish adjustment of wages at the aggregate level reflects genuine wage rigidity rather

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\(^8\) See Snellman (2005) for a more detailed description of the wage bargaining process in Finland.

\(^9\) There is more variability in wage changes for manual workers. We should note that the distribution of wage changes for manual workers in 1992-1993 is similar to the distribution of wages changes in other year. In part, this distribution reflects the fact that earnings of manual workers are more variable due to changes in hours worked. Changes in wage rates are much more downward rigid (see Snellman, 2004).
than compositional changes in employment. We conclude that wage stickiness was a prominent feature of the labor markets during the depression.

**Detrending and Synthetic Sectors**

Time series for key macroeconomic variables grow over time. Since our study does not attempt to explain the steady state growth rate, we filter out the trend and analyze detrended series. Appendix Figure 1 plots the dynamics of the series and the fitted linear time trend. To exclude the effect of the post-Soviet period we use data only for 1975-1989 to fit the time trend. We interpret the trend as the (counterfactual) dynamics of variables that we would have observed if there were no collapse of the Soviet Union and interpret deviations from trend as an impulse response to the Soviet trade shock. To make the comparison between model and data series straightforward, we rescale the filtered series so that they are equal to zero in 1990, see Figure 7. Note that the detrended series exhibit a much stronger decline than the raw series. For example, real value added falls by 13%, while filtered real value added decreases by almost 20%. In addition, macroeconomic series seem not to recover from the shock. Output, consumption, investment and other series stay permanently below the trend.

Further analysis of the Finnish recession requires construction of the Soviet sector. Ideally we would like to have firm level data with product output and export by destination. With this information, we could aggregate output of goods predominantly exported to the Soviet Union and treat this aggregate as the Soviet sector. The advantage of this approach is that we would be able to control for entry/exit decisions at the firms level as well as creation and destruction of products. These data would also allow us to assess to what extent trade with the USSR was redirected to other countries. Unfortunately, these data are not available and we construct Soviet sector from industry level data. The risk of working with industry data is that there could intra-industry entry and exit of firms and products. For example, shipbuilding firms specialized in producing icebreakers for the USSR left the market while shipbuilding firms specialized in producing cruise liners entered the market. In light of this caveat, we prefer the following approach.

Define $\omega_{it}^X$ as the share of exports of industry $i$ at time $t$ to the Soviet Union in total exports of industry $i$. Let $Q_{it}$ be value added (or any other variable of interest) in industry $i$ at time $t$. Then we compute value added in the Soviet sector as $Q_{it}^S = \sum_i \omega_{it}^X Q_{it}$ and correspondingly the non-Soviet sector is $Q_{it}^{NS} = \sum_i (1 - \omega_{it}^X) Q_{it}$. To control for entry and exit of firms and
products, we assume that Soviet sector shares in exports to the post-USSR period are fixed at 1992 values when the trade with the Former Soviet Union countries reached its minimum. We also fix Soviet sector share at 1988 values for the period before 1988 to eliminate extraordinary expansion of the Soviet sector during the period of very high oil prices in the late 1970s and early 1980s. (Recall that trade between USSR and Finland require balanced trade and Soviet-Finnish trade agreements stipulated volumes of trade rather than values.) Thus we allow $\omega_t^X$ to vary only between 1988 and 1992. We refer to the resulting weights as to ‘hybrid’ shares. We treat services as a separate sector producing non-tradable goods. We provide details on data sources and construction of sectors in the data Appendix.

We plot series for Soviet, non-Soviet and service sector in Appendix Figure 2. Again, since most series grow over time we remove the trending component using linear filter estimated on 1975-1989 data (Figure 7). The Soviet sector exhibited the largest decline. Value added, investment, and labor collapsed. There was also a significant, permanent decline in the service sector. The non-Soviet sector experienced a contraction in 1991-1993, but then it gradually recovered and exceeded its pre-collapse levels. Importantly, wages in each sector gradually decreased during the recession years.

III Model

Production

The economy consists of three sectors. The first sector (non-Soviet) produces a traded good consumed at home and sold abroad. The second sector (Soviet) produces a good that can be consumed at home and also sold exclusively to the Soviet Union. The third sector (service) produces non-tradable goods. In sector $j = 1,2,3$, a representative firm solves the following problem:

$$
\sum_{t=0}^{\infty} \left( p_j Q_j - p_j^E E_j - w_j L_j - p_j I_j \right)
- p_j \left( \phi_j K_{jt} - K_{j,t-1} - 1 \right)^2 K_{j,t-1} + p_j \left( \frac{w_j}{L_{j,t-1}} - 1 \right)^2 I_{j,t-1} + \frac{\lambda_j}{2} \left( \frac{L_{j,t-1}}{L_{j,t-1}} - 1 \right)^2 L_{j,t-1})
$$

where $Q$ is physical output, $R$ is the gross interest rate, $K$ is capital stock, $L$ is labor input, $E$ is energy input, $I$ is investment, $p_j$ is the price of good in sector $j$, $p_j^E$ is the price of energy, and $w_j$ is the wage in sector $j$. Investment is defined as $I_j = K_j - (1-\delta)K_{j,t-1}$. Parameters $\phi_j, \psi_j, \lambda_j$...
describe capital, investment and labor adjustment costs respectively. We assume that output in sector 1 is numeraire so that \( p_{1t} = 1 \).

Production function is given by \( Q_{jt} = Z_{jt} \min \left\{ a_{jt} E_{jt}, (\alpha_{jt} K_{jt+1}^{\rho_j} + \alpha_{jt} L_{jt}^{\rho_j})^{1/\rho_j} \right\} \) where \( a_{jt} E_{jt} \) is the energy requirement in sector \( j \), \( 1/(1 - \rho_j) \) is the elasticity of substitution between capital and labor, \( \alpha_{jt} \) and \( \alpha_{jt} \) are weights in the capital-labor aggregator, \( Z_{jt} \) is the level of technology in sector \( j \), and \( \gamma_j \) returns to scale in sector \( j \). At optimum, no input is wasted and hence \( a_{jt} E_{jt} = Q_{jt} \). For convenience define value added as \( Y_{jt} = p_{jt} Q_{jt} - p_{jt}^{E} E_{jt} = (p_{jt} - p_{jt}^{E}) Q_{jt} \) and the corresponding value added function as \( F_j (K_{jt-1}, L_{jt}, p_{jt}, p_{jt}^{E}) \equiv Y_{jt} \). Since in general returns to scale are not equal to one, economic profit in sector \( j \) is \( \pi_{jt} = Y_{jt} - w_{jt} L_{jt} - (\delta + R_j) p_{jt} K_{jt-1} \).

If \( v_{jt} \) is the shadow value of investment in sector \( j \), then the first order conditions are

\[
\frac{\text{SNPV}}{\text{dm}_{jt}} = -v_{jt} + R_{jt+1}^1 F'_{jt+1} + R_{jt+1}^1 (1 - \delta) v_{jt+1} + R_{jt+1}^1 F'_{jt+1} \phi \left( K_{jt+1} - 1 \right) = 0
\]

\[
\frac{\text{SNPV}}{\text{de}_{jt}} = -v_{jt} + p_{jt} + p_{jt} \phi \left( K_{jt+1} - 1 \right) + p_{jt} \psi \left( L_{jt+1} - 1 \right) + R_{jt+1}^1 p_{jt+1} \psi \left( L_{jt+1} - 1 \right) = 0
\]

\[
\frac{\text{SNPV}}{\text{dk}_{jt}} = F_{jt+1} - w_{jt} \beta \left( L_{jt+1} - 1 \right) + p_{jt+1} \beta \left( L_{jt+1} - 1 \right) + p_{jt+1} \beta \left( L_{jt+1} - 1 \right) = 0
\]

Note that in this model the sectors do not have direct linkages via input-output relationships. We also do not allow capital utilization to vary in response to shocks.

**Households**

We assume that a representative household maximizes utility \( \ell \equiv \sum_{t=0}^{\infty} \beta^t U(G_t, L_{1t}, L_{2t}, L_{3t}) \) subject to \( S_t = R_t S_{t-1} + w_{1t} L_{1t} + w_{2t} L_{2t} + w_{3t} L_{3t} - C_{1t} - p_{2t} C_{2t} - p_{3t} C_{3t} - p_{4t} C_{4t} + \pi_{1t} + \pi_{2t} + \pi_{3t} \), where \( G_t \) is consumption aggregator, \( L_t \) is labor supply to sector \( j \), \( C_j \) is consumption of good \( j \), and \( S_t \) is wealth. Here good \( C_4 \) is imported from abroad and not produced domestically. To eliminate wealth effects on labor supply, we follow Greenwood, Hercowitz and Huffman (1988) and assume \( U(G_t, L_{1t}, L_{2t}, L_{3t}) = \frac{1}{1-\sigma} \left( G_t - \frac{\chi_1}{\eta_{1t}} L_{1t}^{\eta_{1t}} - \frac{\chi_2}{\eta_{2t}} L_{2t}^{\eta_{2t}} - \frac{\chi_3}{\eta_{3t}} L_{3t}^{\eta_{3t}} \right)^{1-\sigma} \) where \( \sigma \) is the elasticity of intertemporal substitution, \( 1/\eta_j \) is the elasticity of labor supply in sector \( j \) and \( \chi_j \) is the scale of disutility from working in sector \( j \). Note that labor is sector specific and hence wages are not generally equalized across sectors. Aggregate labor supply is \( L_t = L_{1t} + L_{2t} + L_{3t} \).
We assume that the consumption aggregator is given by
\[ G_t = \left\{ \zeta_1 \tilde{C}_{1t}^{pc} + \zeta_2 \tilde{C}_{2t}^{pc} + \zeta_3 \tilde{C}_{4t}^{pc} + \zeta_4 \tilde{C}_{4t}^{pc} \right\}^{1/\rho_c} \] where \( 1/(1 - \rho_c) \) is the elasticity of substitution in consumption, \( \zeta_j \) are weights in the consumption aggregator, \( \tilde{C}_{jt}^{pc} = \frac{1}{1-h_j} C_{jt} - \frac{h_j}{1-h_j} C_{j,t-1} \) is the habit-adjusted consumption for good \( j \), and parameter \( h_j \) describes habit in consuming good \( j \).

Let \( \mu_{jt} \) be the marginal utility of wealth. Then the first order conditions for this maximization problem are
\[
\frac{\partial \tilde{C}_{ct}}{\partial \mu_{ct}} = U'_{c_j} - \mu_{ct} = 0
\]
\[
\frac{\partial \tilde{C}_{2t}}{\partial \mu_{ct}} = U'_{c_2} - p_{2t} \mu_{ct} = 0
\]
\[
\frac{\partial \tilde{C}_{3t}}{\partial \mu_{ct}} = U'_{c_3} - p_{3t} \mu_{ct} = 0
\]
\[
\frac{\partial \tilde{C}_{4t}}{\partial \mu_{ct}} = U'_{c_4} - p_{4t} \mu_{ct} = 0
\]
\[
\frac{\partial \tilde{C}_{ct}}{\partial \mu_{ct}} = U'_{t_j} + w^0_{jt} \mu_{ct} = 0
\]
\[
\frac{\partial \tilde{C}_{2t}}{\partial \mu_{ct}} = U'_{t_2} + w^0_{2t} \mu_{ct} = 0
\]
\[
\frac{\partial \tilde{C}_{3t}}{\partial \mu_{ct}} = U'_{t_3} + w^0_{3t} \mu_{ct} = 0
\]
\[
\frac{\partial \tilde{C}_{ct}}{\partial \beta} = -\mu_{ct} + \beta R_{t+1} \mu_{t+1} = 0
\]

Note that we use \( w_{jt}^0 \) to denote the reservation wage of household in sector \( j \). In economy without frictions, the reservation wage is equal to the actual wage, i.e., \( w_{jt}^0 = w_{jt} \).

**General Equilibrium**

We assume that in the pre-collapse steady state capital is owned by domestic households so that net foreign position is zero and domestic savings are equal to the value of the capital shock:
\[ S_t = K_{1t} + p_{2t} K_{2t} + p_{3t} K_{3t}. \]

In each sector, output is consumed, invested or exported:
\[
Q_{1t} - C_{1t} - I_{1t} - X_{1t} = 0,
\]
\[
Q_{2t} - C_{2t} - I_{2t} - X_{2t} = 0,
\]
\[
Q_{3t} - C_{3t} - I_{3t} = 0,
\]
where \( X_1 \) and \( X_2 \) are exports in non-Soviet and Soviet sectors respectively.

We assume that Finland has no domestic production of energy and energy is not storable so that import of energy is equal to consumption of energy:
\[
M_t + \tilde{M}_t = (E_{1t} + E_{2t} + E_{3t}) = 0,
\]
where $M_i^*$ is the import of energy from the Soviet Union and $M_i^*$ is import of energy from the rest of the world. To capture the clearing system in the Finnish-Soviet trade, we assume that the trade with the Soviet Union is balanced in all times:

$$p_{2t}X_{2t} - p^s_{M}M^s = 0,$$

where $p^s_t$ is the price of oil from the Soviet union.

Since there is no surplus or deficit in the Finnish-Soviet trade, the trade balance equals to

$$TB_t = X_{1t} - p^*_tM^*_t - p_{4t}C_{4t}.$$

To close the model, we need to specify how reservation wages are related to wages faced by firms. To capture slow adjustment of wages, we assume that real wages evolve as follows:

$$w_{it} = \theta_1 w_{1,t-1} + (1 - \theta_1)w^D_{1t},$$

$$w_{2t} = \theta_2 w_{2,t-1} + (1 - \theta_2)w^D_{2t},$$

$$w_{3t} = \theta_3 w_{3,t-1} + (1 - \theta_3)w^D_{3t},$$

where parameter $\theta$ governs the degree of wage stickiness. A possible interpretation of these dynamics is that trade unions take the wage in the previous period as a starting point in bargaining (“status quo” wages) and gradually change the wage to increase the employment of union workers. Specifically, $\theta = 1$ corresponds to complete real wage rigidity, while $\theta = 0$ corresponds to complete real wage flexibility. Regardless of $\theta$, $w^D_j = w_j$ in the pre-shock steady state.

**Calibration**

The model is calibrated at quarterly frequency. The quarterly depreciation rate of capital is the same across sectors and equal to $\delta = 0.025$ (i.e., approximately 10% at the annual frequency). Discount factor is $\beta = 0.99$ so that the real rate or return is 4% per annum. Following Mendoza and Tesar (1988) and others, we calibrate intertemporal elasticity of substitution as $1/\sigma = 1/2$.

Micro level studies favor very large values for $\eta$, so that the labor supply elasticity (Frisch) $1/\eta$ is small. On the other hand, macro level models need relatively large labor supply elasticity to generate large movements in labor. We take an intermediate value of $\eta = 1$.

We assume unit elasticity of substitution in consumption, i.e., $\rho_c = 0$. Given this assumption, consumption shares can be computed from the input-output matrices which provide
us with the information on consumption expenditures by sector. We find that \( \zeta_1 = 0.04; \zeta_2 = 0.15; \zeta_3 = 0.54; \zeta_4 = 0.27 \).

Our baseline calibration assumes that the production function is Cobb-Douglas (i.e., \( \rho_p = 0 \)). In this case, we can read the \( \alpha_{jL} \) from the labor shares in sector \( j \). In 1989, shares of labor compensation in value added were \( \alpha_{1L} = 0.57 \), \( \alpha_{2L} = 0.63 \) and \( \alpha_{3L} = 0.63 \) for the non-Soviet, Soviet, and service sectors respectively. Empirical studies tend to find that the elasticity of substitution between capital and labor is smaller than one. Thus, we also experiment with \( \rho_p = -1 \), which implies 0.5 elasticity of substitution between capital and labor.

In our baseline calibration, we assume that production functions in all sectors have constant returns to scale. Rotemberg and Woodford (1995) and Basu and Fernald (1997) argue that the share of economic profits in the US economy is about 3%, which implies that returns to scale is approximately 0.97. Given that Finland has more concentrated industries, the share of economic profit should be larger. In alternative calibrations, we consider returns to scale equal to 0.95.

We define units of oil in such a way that the unit price of oil before the collapse of the Soviet Union is equal to one (i.e., the price of the numeraire). Kajaste (1992) argues that the price of oil from the Soviet Union was at least 10% cheaper than the price of oil from the rest of the world. After the collapse of the Soviet Union, there is no subsidy to the Finnish economy and the price of oil is set to 1.1.

Because energy and value added are Leontieff complements, the energy requirement in the non-Soviet sector is given by \( a_i = Q_i / E_i = p_i Q_i / p^E_i E_i \). Since we know the cost structure (specifically expenditures on energy), we can compute energy requirement for the non-Soviet sector as the ratio of cost (value added plus energy expenditures) to energy expenditures. For the non-Soviet sector this ratio is equal to 13.7. For other sectors, we cannot make this calculation directly because it depends on prices determined in equilibrium. However, we require that given prices for goods 2 and 3 the ratio of cost to energy expenditures is 12.2 and 12.8 respectively as in the data.

The remaining parameters \( (p_4, \chi_1, \chi_2, \chi_3, Z_1, Z_2, Z_3) \) are calibrated to match the fact that trade with the USSR was 17.5% of total export and 60% of output in the Soviet sector, the size of the Soviet sector was 5.9% and 5.6% in terms of employment and value added, the size of the
service sector was 69.5% and 67.5% in terms of employment and value added.\(^{10}\) Since more than 90% of energy was imported from the USSR we assume that in the pre-collapse period no energy was imported from other countries.

Parameters describing habit formation, adjustment costs and real wage stickiness cannot be calibrated from steady state ratios. Hence, we rely on alternative sources to assign values to these parameters. We assume small to moderate adjustment costs in capital stock \((\phi_1 = \phi_2 = \phi_3 = 1)\) and labor \((\lambda_1 = \lambda_2 = \lambda_3 = 1)\). Basu and Kimball (2005) and Christiano, Eichenbaum and Evans (2005) report that investment adjustment costs are necessary to explain the response of macroeconomics aggregates to supply side shocks. We follow these authors and introduce a small cost to changing the flow of investment: \(\psi_1 = \psi_2 = \psi_3 = 0.5\). This small cost helps to generate a smoother contemporaneous response of investment to shocks. Numerous studies find a significant habit in consumption. A typical range is between 0.7 and unity. We take an intermediate value of habit persistence and set \(h_1 = h_2 = h_3 = 0.8\). As we have discussed above, wages in Finland are downward rigid and wage adjustment in the early 1990s was very slow. Indeed, we do not observe large movements in real or nominal wages in Finland over the 1990s (see Figure 7). In light of these facts, we set \(\theta_1 = \theta_2 = \theta_3 = 0.99\).\(^{11}\)

**Simulations**

In this section we present the perfect-foresight response of the Finnish economy to the collapse of trade with the Soviet Union. This event had two major components. First, Finland lost one of its major export markets and because of the relation specificity with the USSR Finnish firms could not easily redirect trade to other countries. We model this part of the shock as a contraction of \(M^S_t\) to zero.\(^{12}\) Second, Soviet Union subsidized Finland with cheap energy. Our discussion in previous sections suggests that the subsidy was about 10% of the oil price. Collapse of the Finnish-Soviet trade eliminated the subsidy and thus we assume that the second part of the shock was an increase in the oil price from \(p^E = 1\) to \(p^E = 1.1\). We hit our model economy with these shocks and trace its dynamic response.\(^{13}\)

\(^{10}\) With Cobb-Douglas consumption aggregator, \(p_4\) can be normalized to be equal to one.

\(^{11}\) For our main results it is sufficient to have strong wage rigidity only in the non-Soviet sector.

\(^{12}\) As Sutela (1992) observes, Finland imported 94% of its crude oil from the USSR. In the 1991 the share dropped to 34 percent. This decline was determined by several forces: the end of clearing trade, more stringent environmental standard, and Russian supply problems. Later supplies of oil from Russia recovered to approximately 50% (Sutela 2005).

\(^{13}\) We used shooting and linearization around post-shock steady state to adjust impulse responses for the steady state changes in the net foreign position. The quantitative results were similar to the results reported in the paper.
Figure 8 plots actual and simulated response for key macroeconomic variables. The model can capture the dynamics of output well in terms of timing and magnitude. The model correctly predicts 20% fall of output below the trend, the through two-three years later after the shock, and a subsequent recovery. The simulated series for wages is also reasonably close to the actual dynamics. The model can explain a bulk of decline in consumption and employment. For instance, the impulse response for consumption in the model is about -16% while the contraction in the data was about 22% below the trend. Likewise, the model predicts a 20% contraction in labor supply, which is close to the 24% contraction in the data. The timing of the trough in the model response for consumption roughly coincides with the timing of the trough in the data. However, the model predicts recovery in consumption to 15% below the trend while consumption in the data does not seem to recover and stays permanently 20-22% below the trend. Modeled employment response is more successful at matching timing of the trough and moderate recovery of employment.

The model predicts a 30% decline in investment over 1991-1993 and a recovery to 10% below the trend in the long run. In contrast, investment in the data falls by 65% below the trend and although it slightly recovers by 1998 it stays permanently 40% below the trend. However, one may expect that if utilization of capital requires energy as in Finn (2000), the relative price of capital is going to be higher in the post-collapse period and hence decline in investment at long horizons will be larger.

Figure 9 though Figure 11 show the model and data response at the sectoral dimension. Generally, the model captures well the dynamics in the Soviet and service sectors. Although the model reproduces qualitative features of the dynamics in the non-Soviet sector, it does not track quantitatively the data series well. For example, output in the non-Soviet sector in 1992 falls by 3% in the model and by 20% in the data.

The overall performance of the model appears to be satisfactory at reproducing the dynamics of macroeconomic variables. At the same time, the model is less successful at explaining the sectoral dynamics. Specifically, we can match the responses of Soviet and service sectors, but we are less successful at matching the response of the non-Soviet sector. Specifically, the model understates contraction in the non-Soviet sector.

To assess the contribution of oil price and trade shocks, we perturb the economy with one shock at a time and plot resulting aggregate variable responses (see Figure 8). The economy’s response to an oil price shock is much smaller than the response of the economy to losing a major trading partner. In addition, oil price shock tends to relatively expand the Soviet sector,
which is consistent with the Finnish experience when oil prices increased in late 1970s and early 1980s (Figure 9). On the other hand, trade shock leads to an expansion in the non-Soviet sector (Figure 10). In general, oil and pure trade shocks push Soviet and non-Soviet sectors in different directions. Both shocks are contractionary for the service sector (Figure 11).

In the remainder of the section we vary parameter values to inform the reader about sensitivity of our results to alternative calibrations. Both habit formation and adjustment costs make the response smoother, but neither adjustment costs nor habit formation are crucial for the qualitative results (Figure 12). Our qualitative results are not sensitive to changes in the production function parameters (Figure 13). Increasing elasticity of substitution dampens the response of investment and amplifies the response of labor. The quantitative results change little when we decrease returns to scale from 1 to 0.95. Likewise, we find that elasticity of substitution in consumption across goods and over time does not change our main results (Figure 14). We also find that as long as labor supply is upward sloping and convex \((\eta > 1)\), we obtain the similar quantitative results.

The key parameter governing the response of the macroeconomic variables to collapse of the Soviet-Finnish trade is persistence of real wages (Figure 15). In the case with fully flexible wages, the recession is short and shallow. For example, employment and consumption fall only by 5% and there is little dynamics after the first year. Likewise, output and investment decline only by 10%. Thus, the response of investment, output, consumption and employment is small when compared to the response of these variables in the data. On the other hand, the response of real wages is overstated. In the data, wages declined gradually, while the model with fully flexible wages predicts an immediate 12% decline. At the sectoral dimension, fully flexible wages fail to response the contraction across sectors. In particular, non-Soviet sector expands in response to the collapse of the Soviet-Finnish trade: as resources are released from the Soviet sector they flow into the relatively more productive non-Soviet sector.

In contrast, when wages are rigid, oil shock reduces the marginal product of labor and firms would like to hire less labor at the current wages or to keep employment fixed but cut wages. If wages are rigid, the adjustment goes via quantities and the model can capture sizable permanent decreases in output, consumption, investment and labor. The recession is considerably deeper when wages are inflexible. Obviously, if wages are fixed, the model misses gradually decreasing wages. In summary, our qualitative and, to a large extent, quantitative results depend only on adjustment of real wages being sufficiently slow.
**Oil shock in 1974**

Given good performance of the model in explaining the recession in the 1990s, one might be interested in how the model fares in accounting for the macroeconomic dynamics after the oil price shock in 1974. If the model dynamics are consistent with the observed data, we may be more confident in our conclusions in the previous subsection. In this exercise, we keep the model calibrated as before. The only modification we make is the speed of wage adjustment, which we set to $\theta_1 = \theta_2 = \theta_3 = 0.9$. This modification captures the fact that Finland was less unionized in early 1970s.

Although most economies experienced the shock early in 1974, the shock to the Finnish economy was somewhat delayed because the oil price in the Finnish-Soviet trade was a moving average of the world price. Hence, we assume that the shock to the world price occurs in the first quarter of 1974 and it hits the Finnish economy in the last quarter of 1974. To calibrate the size of the shock, we compute the unit price of imported oil in 1973 and 1974 and find that the (log) change in the price was 109%.

Figure 17 plots the model impulse response to the oil price shock and the dynamics of actual output, consumption and investment. Similar to previous analyses, we detrend data to remove secular movements in macroeconomic variables. The model broadly matches the response of the economy. In particular, the model correctly predicts the timing and the depth of contraction in consumption. The model and data responses for output and investment have the same decline. However, the trough in the model response for output and investment occurs before the trough in the data. Although we do not have sectoral data before 1975 to construct counterfactual movements in the data in the absence of the shock, we know from Figure 4 and Figure 5 that exports to the USSR expanded in response to the oil sector. We also know that output in the Soviet sector expanded relative to output in the non-Soviet sector. The sectoral responses in the model (not reported) capture these facts as well.

**IV Alternative explanations of the depression**

In this section, we briefly assess several alternative theories of the Finnish depression. Obviously, such a major downturn in economic activity had many causes. Hence, we only attempt to compare our explanation with the alternatives and provide a sense of quantitative importance.
In a recent paper, Conesa, Kehoe and Ruhl (2007) argue that the depression was caused by an adverse total factor productivity (TFP) shock and increased labor taxes. In Zvi Griliches words, TFP shocks are a measure of economists’ ignorance and obviously sources of TFP shocks are not clear. However, we can reconcile findings in Kehoe and Ruhl (2007) with our story. Note that oil price shock works like a technology shock since an increase in the oil price reduces firms’ profit margins (provided there is a sufficiently small substitutability of energy input). Thus what Conesa, Kehoe and Ruhl (2007) interpret as a TFP shock could be in fact a shock to energy prices. Indeed, measured productivity in our model is \( \left(1 - \frac{\rho^e_i}{a_{j,E} p_p}\right) Z_j \) which decreases as the energy price rises. Likewise, one may expect that unobserved factor utilization would lead to decreased measured productivity. The advantage of our story is that we can identify the source of the shock while Conesa, Kehoe and Ruhl (2007) cannot.

We were not able to find information on changes in tax rates in the Finnish press and legislation. Various measures of the tax burden on labor earnings exhibit very little variation over the 1990s (Figure 18). Minor changes in the tax laws enacted to bring the Finnish legislation to the European standards were too minor to be important for aggregate dynamics. However, we can also explain the ‘source’ of labor taxes.

Note that labor taxes drive a wedge between the wage paid by firms and wage received by workers. In equilibrium without frictions, the wage received by workers is equal to their reservation wage, i.e. \( w_{jt} = w^D_{jt} \). If wages are rigid, then the reservation wage is not generally equal to the actually received wage. Furthermore, in a downturn, workers are willing to accept jobs at lower wages, but with inflexible wages there is going to be a difference between current market wage and the reservation wages, in particular \( w_{jt} > w^D_{jt} \). Furthermore, if firms stay on their labor demand curve, they will cut employment. To reconcile decreased employment with assumed fully flexible wages, there should be a ‘labor tax’ shock. In other words, one can interpret \( w_{jt} > w^D_{jt} \) as arising from a labor tax \( \tau \) such that \( w_{jt} > (1 - \tau) w^D_{jt} = w^D_{jt} \) where after tax wage is equal to the reservation wage. As we indicated above, we could not find evidence to support increased labor taxes in the recession but we have evidence that wages barely moved in the recession. Hence, our results do not contradict results in Conesa, Kehoe and Ruhl (2007), but there is an important difference in interpretation.

Another popular explanation of the Finnish depression was a credit crunch induced by a burst of the overheated stock market and collapse of the Soviet-Finnish trade. Although we do
not have any explicit role for credit in our model, we can get a sense of whether and to what extent credit crunch can explain the depression. In particular, we model the credit crunch as an exogenous, persistent increase in the interest rate. This exogenous change in the interest rate could be interpreted as the passive response of the banking (lending) sector.\footnote{One can alternatively interpret interest rate shock as an exogenous change due to German reunification which...} We assume that the interest rate increased in 1991 by one percent. At this point the scale is not so important since the model is linear and we are mainly interested in whether an interest rate shock can reproduce dynamics in the data. We set the serial correlation of the shock to 0.9 which is approximately the persistence of the interest rate in Finland. We consider two scenarios. First, the interest rate shock is the sole source of the depression. Second, the interest rate shock happens simultaneously with the collapse of the Soviet-Finnish trade. We present impulse responses in Figure 16. Clearly, an increase in the interest rate depresses economic activity at the aggregate level and improves the fit of the model at the sectoral level when combined with other shocks. Specifically, interest rate shock helps to match the downturn in the non-Soviet sector. By itself, however, the shock has small quantitative effects for variables other investment. In addition, investment tends to overshoot after the period of high interest rates. It appears that the credit crunch theory is a useful complement to our story.

V Extensions to Transition Countries

The tendency to overprice machines exported from CMEA countries to the Soviet Union and underprice raw materials (mainly energy) exported from the Soviet Union to CMEA countries is well known and documented (e.g., Marrese and Vanous 1983). Furthermore, there is evidence of the same pattern for the intra-USSR trade (e.g., Brown and Belkindas 1992, Krasnov and Brada 1997). One manifestation of this subsidy is very high energy use per value added in many transition countries (see EBRD Transition Report 2001). Although there was an element of economic reasoning behind the subsidy (e.g., Brada 1985), it was mainly a political motive to keep CMEA countries on the short leash (Marrese and Vanous 1983). Hence, the subsidy for Finland and CMEA countries had similar political underpinnings.

Like Finnish exports to the USSR, exports of CMEA countries to the USSR were highly specialized and hence reorientation of trade was at least equally difficult for transition countries. Although we observe a strong redirection of trade for transition countries from former socialist trading partners toward EU and other industrialized countries (e.g. Campos and Coricelli 2002),...
we have little evidence that exports of goods manufactured in the command economy were redirected. Rodrik (1994) and others argue that reorientation to the EU market of products previously directed to CMEA was not a prominent feature of the transition period. Furthermore, Rodrik (1994) reports evidence suggesting that Soviet exports could be sold in the West only with 50% or more discounts. Given available micro level evidence, Repkine and Walsh (1999) contend that firms historically producing under different 5-digit SITC codes for the CMEA market could hardly reorient production toward very different products.15

Our simulation results suggest that the elimination of subsidy and trading partner should be complemented with real wage rigidities to generate significant movements in output, employment and other aggregate outcomes. Because of data limitations, it is hard to establish whether real wages were rigid in Central and Eastern European countries in the initial stages of the transition. First estimates of the wage elasticity with respect to unemployment rates suggested that real wages were fairly flexible in transition countries (e.g., Blanchflower 2001). However, subsequent studies based on macro and micro level data tend to find that real wages in transition countries were almost as inflexible as wages in other European countries (e.g., Kertesi and Kollo 1997, Estevão 2003, Iara and Traistaru 2004, Von Hagen and Traistaru-Siedschlag 2005). In addition, labor markets in transition countries appear to be as regulated as in other European countries (Botero et al 2004). It is hard to believe that real wages were strongly inflexible because inflation was high and variable. However, there was also a strong political pressure to maintain living standards. Indeed, Roland (2000) argues that politicians could not allow wages to fall too fast and too much because otherwise reforms could be reversed. Wage indexation and dollarization of wages became common practice in transition economies. Furthermore, as observed in Rodrik (1994), the sharp increase in unemployment rate across transition countries is the prima facie evidence that wages were inflexible. In summary, although wages in transition countries adjusted in response to aggregate shocks, the adjustment is likely to have been relatively slow. Given that the size of distortions was greater in former CMEA countries (e.g., greater subsidy from USSR and greater specialization of trade with the USSR), one can expect that standard macroeconomic factors can explain a bulk of downturn in economic activity in transition countries.

happened around the same time.

15 At the same time, Repkine and Walsh (1999) find that exports for most transition countries were clustered in a narrow list of products at the 3-digit level disaggregation before and after the collapse of the command economy. Furthermore, the clustering of exported products persisted from 1993 onwards. Of course it does not mean that firms
To support our theory of contraction in the transition countries, we need to compare simulated model responses with the data responses at the aggregate and sectoral levels. Unfortunately, due to severe data limitations, this comprehensive analysis is not possible. Indeed, we focus on Finland precisely because, unlike transition countries, Finland has reliable statistics at all levels of aggregation during and before the recession. However, we can assess the model’s behavior using a handful of reliable aggregate series for Poland and Hungary.

We use the model and calibration from section V as the basis of our analysis for transition economies. Since transition and Finnish economies were different, we need to make a few adjustments to the calibration. Relative to the baseline parameter values, we allow faster adjustment of real wages by setting $\theta_1 = \theta_2 = \theta_3 = 0.96$. We also modify the expenditure shares to match the relative sizes of the sectors. Specifically, we assume $\xi_1 = 0.2, \xi_2 = 0.15, \xi_3 = 0.5, \xi_4 = 0.15$ for Hungary and $\xi_1 = 0.2, \xi_2 = 0.15, \xi_3 = 0.45, \xi_4 = 0.2$ for Poland to match the fact that service sector was larger in Hungary. These modifications in $\xi$'s as well as adjustments in $\chi$ are necessary to match the size of the Soviet sector, which we set to 20-25% in Poland and Hungary, and the share of Soviet exports in total exports, which we set to 30% in both countries.

To calibrate the size of the shock, we use the decline in the volume of exports to the (former) USSR as well as dependence of Poland and Hungary on energy imports from the Soviet Union. Hungary was heavily dependent on energy supplies from the USSR and the quality of its exports was inferior relative to Finnish exports to the USSR. Hence, we double the markup and assume that after the collapse of the Soviet Union the price of oil is effectively 20% more expensive relative to the pre-collapse price. Poland was less dependent on energy imports from the USSR and, consequently, we assume a 15% markup. To assess the size of the trade shock, we use the fact that between 1988 and 1991 exports to the USSR decreased by 60-65% for Hungary and by 45-50% for Poland. Consequently, we set trade shocks to 65% and 50%.

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16 In 1991 (the earliest year for which we have reliable data), services accounted for 57% of GDP in Hungary. In 1992 (the earliest year for which we have reliable data), the share was 51% in Poland. Since services contracted less during the recession, we set sector shares to small magnitudes.

17 We do not have reliable data to assess the size of the Soviet sector. However, various sources indicate that approximately a quarter of the CMEA economies were primarily concerned with exports to the USSR. The share of Soviet exports is calculated using IMF Direction of Trade Statistics (DOTS) database.

18 Export statistics are taken from IMF Direction of Trade Statistics (DOTS) database. Other data sources (OECD, national statistical offices) report similar magnitudes.
Finally, we assume that the collapse of the Soviet trade occurred (or started to occur) in 1990 rather than 1991.

Figure 19 plots the dynamics of real GDP in the model and data to the Soviet trade shock. Strikingly, the model response to collapse of the Soviet trade is very similar to the actual response of the Polish and Hungarian economies. The model can match the size of the output contraction in both economies and the timing of the trough for Poland. For Hungary, the model predicts a much faster decline in output than we observe in the data. Overall, our results suggest that the Soviet trade shock could have been a quantitatively important source of economic downturn in transition countries.

VI Concluding Remarks
In this paper we analyze an effect of an exogenous trade shock on the Finnish economy. We find that the depression experienced by the Finnish economy in 1991-1993 can be explained to a large extent by the collapse of the trade with the Soviet Union. Given that post-socialist economies exhibited output dynamics and Soviet trade patterns similar to those in Finland, we argue that economic collapse of formerly socialist economies in the early 1990s could have been mainly due to the trade shock. Although we cannot rule out alternative explanations for contractions in these countries, the quantitative responses to the Soviet trade shock can account for almost full amount of contraction in transition countries and Finland thus leaving relatively little space for other theories. One may also expect that the Finnish experience can also shed some light on the post-WWII contractions in Argentine and New Zealand and possibly other historical episodes of rapid reductions in exports and subsequent collapse of output.

The natural experiment of the Soviet-Finnish trade downfall analyzed in this paper has broader implications. Specifically, we show that sectoral (trade) shocks can lead to significant comovement across sectors even in the absence of direct input-output linkages. Reallocation of resources can be particularly costly in presence of sticky wages and/or prices. Static measures of the trade shocks can grossly overestimate the short-run cost of reallocation. Since many small open economies specialize in a handful of goods, shocks to prices of these goods could be an important source of volatility in these countries.
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Appendix: Data

Our major data sources are OECD STAN data base and Finnish statistical yearbooks.

Export: Sectoral data on export by destination is provided by OECD STAN Bilateral Trade database and Finnish statistical yearbooks. From these data we compute the share of trade with the USSR for industry \( j \) in total exports of industry \( j \). For the post-collapse period, we compute the shares using the total trade with Former Soviet Union countries. Service sector is assigned zero share in trade with the USSR. OECD ITCS database is used to construct exports series for 1970-2003. We aggregate exports to 15 former Soviet republics to compute the volume and structure of exports to the (former) USSR after 1991.

Output, investment, employment: Sectoral data on employment, hours of work, investment, output, total labor compensation and wage bill is taken from STAN OECD data base. Investment, output, and wage bill is in 2000 Finnish markka prices. Labor compensation includes wages, salaries, and social costs. Wage is computed as the ratio of wage bill to employment. Labor share is computed as the ratio of total labor compensation to value added. To construct Soviet sector we use export shares as weights to aggregate output, investment, etc. across sectors (see text for further description). Service sector excludes public administration and defense as well as compulsory social security. Since we do not have detailed export and production information for some disaggregated sectors, our level of aggregation varies by sector. In the end, we have complete information on the following sectors in manufacturing:

- Textiles, textile products, leather and footwear
- Wood and products of wood and cork
- Pulp, paper, paper products, printing and publishing
- Coke, refined petroleum products and nuclear fuel
- Chemicals and chemical products
- Rubber and plastics products
- Other non-metallic mineral products
- Basic metals
- Fabricated metal products, except machinery and equipment
- Machinery and equipment, n.e.c.
- Office, accounting and computing machinery
- Electrical machinery and apparatus, n.e.c.
- Radio, television and communication equipment
- Medical, precision and optical instruments, watches and clocks
- Motor vehicles, trailers and semi-trailers
- Other transport equipment
- Manufacturing, n.e.c.
- Electricity, gas and water supply

Output statistics for Poland and Hungary are taken from Penn World Tables 6.2.
**Consumption of energy:** Finnish statistical yearbooks provide information on the cost structure (including consumption of energy) by industry. We use the yearbook for 1993 to get information for the pre-collapse period. Unit prices for oil imports are taken from *Energy Statistics 1994* published by the Statistics Finland.

**Consumption:** Aggregate consumption is taken from IMF IFS data base and Finnish statistical yearbooks. Consumption is in 2000 Finnish markka prices. To compute consumption shares by sector, we use a detailed Input-Output table for 1989. This table provides information for consumption expenditures by sector. We apply export shares as weights and aggregate across sectors to construct domestic consumption of Soviet, non-Soviet, non-tradables (services) and imported goods. Since we do not know the share of domestic private consumption for imported goods and in our model imported goods can be only consumed, we multiply imports by the share of private consumption expenditures in total domestic expenditures (government, investment) and treat the product as the private domestic consumption of imported goods.
Appendix: Log-linearized model

Hats denote percent deviations from steady state.

**Consumer problem**

\[
\begin{align*}
\frac{\partial t}{\partial t} C_t &= \hat{U}'_t - \hat{\mu}_{tt} = 0 \\
\frac{\partial t}{\partial t} C_{t-1} &= \hat{U}'_{t-1} - \hat{\mu}_{tt} = 0 \\
\frac{\partial t}{\partial c_t} C_t &= \hat{U}'_t - \hat{\mu}_{tt} = 0 \\
\frac{\partial t}{\partial c_{t-1}} C_t &= \hat{U}'_{t-1} - \hat{\mu}_{tt} = 0 \\
\frac{\partial t}{\partial c_{t-1}} C_{t-1} &= \hat{U}'_{t-1} + \hat{\mu}_{tt} = 0 \\
\frac{\partial t}{\partial c_{t-1}} C_{t-2} &= \hat{U}'_{t-2} + \hat{\mu}_{tt} = 0 \\
\frac{\partial t}{\partial c_{t-1}} C_{t-2} &= \hat{U}'_{t-2} + \hat{\mu}_{tt} = 0 \\
\end{align*}
\]

Utility

\[
U'_{C_t} = \left( \frac{G_t - \frac{z_1}{\eta_{t+1}} L_{tt}^{n+1} - \frac{z_2}{\eta_{t+2}} L_{t2}^{n+1} - \frac{z_3}{\eta_{t+3}} L_{t3}^{n+1}}{U_0} \right)^{-\sigma} G'_{C_t} = U_0 G'_{C_t} = \frac{1}{1-h} U_0 s_{C_t} G' / C_t = \frac{1-h}{1-h} U_0 s_{C_t} G_{t+1} / C_{t+1}.
\]

Note that in steady state \( \overline{C}_t = C_t \) and \( U_{C_t} = \frac{1-h}{1-h} U_0 s_{C_t} G / C_j \).

\[
\hat{U}_0 = -\sigma (s_G \hat{G}_t + s_t \eta_t \hat{L}_t + s_{t-1} \eta_{t-1} \hat{L}_{t-1} + s_t \eta_{t+1} \hat{L}_{t+1}) \text{ where } s_G = G_t / (G_t - \frac{z_1}{\eta_{t+1}} L_{tt}^{n+1} - \frac{z_2}{\eta_{t+2}} L_{t2}^{n+1} - \frac{z_3}{\eta_{t+3}} L_{t3}^{n+1}) \text{ and } s_t = -\frac{\chi_{t+1}}{\eta_{t+1}} L_{tt}^{n+1} / (G_t - \frac{z_1}{\eta_{t+1}} L_{tt}^{n+1} - \frac{z_2}{\eta_{t+2}} L_{t2}^{n+1} - \frac{z_3}{\eta_{t+3}} L_{t3}^{n+1}).
\]

Hence
\[
\hat{G}_t = s_{C_1} \hat{G}_{t} + s_{C_2} \hat{G}_{t-1} + \hat{C}_t + s_{C_3} \hat{C}_{t-1} + s_{C_4} \hat{C}_{t+1}
\]
\[
\hat{S}_t = \rho_{C} \left[ (1-s_{C_1}) \hat{C}_{t-1} - s_{C_2} \hat{C}_{t-1} - s_{C_3} \hat{C}_{t-1} - s_{C_4} \hat{C}_{t+1} \right] = \rho_{C} \hat{C}_{t-1} - \rho_{C} \hat{G}_{t}
\]

where \( \hat{C}_{t-1} = \frac{1}{1-h} \hat{C}_{t} - \frac{h}{1-h} \hat{C}_{t+1} \).

It follows that
\[
\hat{U}'_{C_t} = \frac{1}{1-h} (\hat{U}_0 + \hat{S}_{C_t} + \hat{G}_t - \hat{G}_{j+1} - \frac{1}{1-h} (\hat{U}_{0,t+1} + \hat{S}_{C_t,t+1} + \hat{G}_{t+1} - \hat{G}_{j+1}) =
\]
\[
= \frac{1}{1-h} (\hat{U}_0 + (1-\rho_{C}) \hat{G}_t + (\rho_{C} - 1) \hat{G}_{j+1}) - \frac{1}{1-h} (\hat{U}_{0,t+1} + (1-\rho_{C}) \hat{G}_{t+1} + (\rho_{C} - 1) \hat{G}_{j+1})
\]
\[
U'_{C_t} = \left( \frac{G_t - \frac{z_1}{\eta_{t+1}} L_{tt}^{n+1} - \frac{z_2}{\eta_{t+2}} L_{t2}^{n+1} - \frac{z_3}{\eta_{t+3}} L_{t3}^{n+1}}{U_0} \right)^{-\sigma} (-\chi_j L_{j+1}^{n}) = -U_0 \chi_j L_{j+1}^{n}
\]
\[ \hat{U}_{i_j} = -\hat{U}_0 - \eta_j \hat{L}_{j} \cdot \]

**Firm's problem in the non-Soviet sector**

\[
\frac{dx}{dt} = -\hat{R}_{t+1} + \frac{F_1}{F_2} \hat{K}_{1,t+1} + \frac{\beta^2}{\rho \rho^2 + p_2 (1-\delta)} \hat{R}_{j,t+1} - \frac{\beta^2 \delta}{\rho \rho^2 + p_2 (1-\delta)} \hat{K}_{j,t} \\
\frac{\hat{A}_{t}}{x_{t+1}} = -\hat{R}_{t} + \phi_1 (\hat{K}_{t} - \hat{K}_{j,t}) + \psi_1 (\hat{I}_{t} - \hat{I}_{j,t}) - \beta \psi_2 (\hat{I}_{t+1} - \hat{I}_{j,t}) = 0 \\
\frac{\hat{X}_{t}}{x_{t+1}} = -\hat{R}_{t} + \hat{W}_{t+1} - \frac{\rho_1}{\rho_2} (\hat{L}_{t} - \hat{L}_{j,t}) + \frac{\rho_2}{\rho_2} (\hat{L}_{j,t+1} - \hat{L}_{j,t}) = 0 \\
\hat{X}_{t} = \frac{\gamma_j}{\gamma_j} \hat{Y}_{t+1} - \frac{\mu}{\sigma_2} (\hat{W}_{t} + \hat{L}_{t}) - \frac{\sigma_2}{\gamma_j} (\hat{K}_{t+1} - \hat{K}_{j,t}) \\
\hat{Q}_{t} = \gamma_j s_{j,k} \hat{K}_{1,t+1} + \gamma_j s_{j,k} \hat{L}_{t} \\
\hat{F}_{t} = \hat{K}_{2,t+1} = \hat{s}_{2,t} + \hat{Y}_{t+1} - \hat{L}_{t} = \rho_p \left[ -s_{2,t} \hat{L}_{t} - s_{j,1} \hat{K}_{j,t} \right] + \hat{Y}_{t+1} + (\rho_p - 1) \hat{L}_{j,t} \\
\hat{F}_{j,t} = \hat{s}_{1,t} + \hat{Y}_{t+1} - \hat{K}_{j,t} + \rho_p \left[ -s_{1,t} \hat{L}_{t} - s_{j,1} \hat{K}_{j,t} \right] + \hat{Y}_{t+1} + (\rho_p - 1) \hat{K}_{j,t} \\
\hat{Y}_{t+1} = \hat{Q}_{t+1} - \frac{p_2^2}{\rho_2} \hat{P}_{t} \\
\hat{E}_{t+1} = \hat{O}_{t} + (1-\delta) \hat{K}_{1,t+1} + \hat{I}_{t} = 0 \\
\]

**Firm's problem in the Soviet sector**

\[
\frac{dx}{dt} = -\hat{R}_{t+1} + \frac{F_1}{F_2} \hat{K}_{1,t+1} + \frac{\beta^2}{\rho \rho^2 + p_2 (1-\delta)} \hat{R}_{j,t+1} + \frac{\beta^2 \delta}{\rho \rho^2 + p_2 (1-\delta)} \hat{K}_{j,t} \\
\frac{\hat{A}_{t}}{x_{t+1}} = -\hat{R}_{t} + \hat{P}_{t+1} - \phi_2 (\hat{K}_{2,t} - \hat{K}_{2,t-1}) + \psi_2 (\hat{I}_{t} - \hat{I}_{2,t}) - \beta \psi_3 (\hat{I}_{t+1} - \hat{I}_{2,t}) = 0 \\
\frac{\hat{X}_{t}}{x_{t+1}} = -\hat{R}_{t} + \hat{W}_{t+1} - \frac{\rho_1}{\rho_2} (\hat{L}_{t} - \hat{L}_{2,t}) + \frac{\rho_2}{\rho_2} (\hat{L}_{t+1} - \hat{L}_{2,t}) = 0 \\
\hat{X}_{t} = \frac{\gamma_j}{\gamma_j} \hat{Y}_{t+1} - \frac{\mu}{\sigma_2} (\hat{W}_{t} + \hat{L}_{t}) - \frac{\sigma_2}{\gamma_j} (\hat{K}_{t+1} - \hat{K}_{2,t}) \\
\hat{Q}_{t} = \gamma_j s_{j,k} \hat{K}_{2,t+1} + \gamma_j s_{j,k} \hat{L}_{t} \\
\hat{F}_{t+1} = \hat{s}_{2,t} + \hat{Y}_{t+1} - \hat{K}_{2,t+1} = \rho_p \left[ -s_{2,t} \hat{L}_{2,t} - s_{j,2} \hat{K}_{j,t+1} \right] + \hat{Y}_{t+1} + (\rho_p - 1) \hat{K}_{j,t+1} \\
\hat{Y}_{t+1} = \hat{Q}_{t+1} - \frac{p_2^2}{\rho_2} \hat{P}_{t} \\
\hat{E}_{t+1} = \hat{O}_{t} + (1-\delta) \hat{K}_{2,t+1} + \hat{I}_{t} = 0 \\
\]

**Firm's problem in the Service sector**

\[
\frac{dx}{dt} = -\hat{R}_{t+1} + \frac{F_1}{F_2} \hat{K}_{1,t+1} + \frac{\beta^2}{\rho \rho^2 + p_2 (1-\delta)} \hat{R}_{j,t+1} + \frac{\beta^2 \delta}{\rho \rho^2 + p_2 (1-\delta)} \hat{K}_{j,t} \\
\frac{\hat{A}_{t}}{x_{t+1}} = -\hat{R}_{t} + \hat{P}_{t+1} - \phi_2 (\hat{K}_{3,t} - \hat{K}_{3,t-1}) + \psi_2 (\hat{I}_{t} - \hat{I}_{3,t}) - \beta \psi_3 (\hat{I}_{t+1} - \hat{I}_{3,t}) = 0 \\
\frac{\hat{X}_{t}}{x_{t+1}} = -\hat{R}_{t} + \hat{W}_{t+1} - \frac{\rho_1}{\rho_2} (\hat{L}_{t} - \hat{L}_{3,t}) + \frac{\rho_2}{\rho_2} (\hat{L}_{t+1} - \hat{L}_{3,t}) = 0 \\
\hat{X}_{t} = \frac{\gamma_j}{\gamma_j} \hat{Y}_{t+1} - \frac{\mu}{\sigma_3} (\hat{W}_{t} + \hat{L}_{t}) - \frac{\sigma_3}{\gamma_j} (\hat{K}_{t+1} - \hat{K}_{3,t}) \\
\hat{Q}_{t} = \gamma_j s_{j,k} \hat{K}_{3,t+1} + \gamma_j s_{j,k} \hat{L}_{t} \\
\]

Firm's problem in the non-Soviet sector

Firm's problem in the Soviet sector

Firm's problem in the Service sector
\[ \hat{F}_{3t} = \hat{s}_{3t} + \hat{Y}_{3t} - \hat{L}_{3t} = \rho_p \left[ -s_{3t} \hat{L}_{3t} - s_{3K} \hat{K}_{3,t-1} \right] + \hat{Y}_{3t} + (\rho_p - 1) \hat{L}_{3t} \]

\[ \hat{F}_{3K} = \hat{s}_{3K} + \hat{Y}_{3t} - \hat{K}_{3,t-1} = \rho_p \left[ -s_{3t} \hat{L}_{3t} - s_{3K} \hat{K}_{3,t-1} \right] + \hat{Y}_{3t} + (\rho_p - 1) \hat{K}_{3,t-1} \]

\[ \hat{Y}_{3t} = \hat{Q}_{3t} + \frac{p_1}{p_1 - p^E/a_{3t}} \hat{p}_{3t} - \frac{p^E/a_{3t}}{p_1 - p^E/a_{3t}} \hat{p}_t^E \]

\[ \hat{E}_{3t} = \hat{Q}_{3t} \]

\[ -\hat{K}_{3t} + (1 - \delta) \hat{K}_{3,t-1} + \hat{i}_{3t} = 0 \]

**General equilibrium**

\[ \hat{\dot{Q}}_{1t} - \frac{C_1}{\tilde{Q}_1} \hat{\dot{C}}_{1t} - \frac{X_1}{\tilde{Q}_1} \hat{\dot{X}}_{1t} - \frac{I_1}{\tilde{Q}_1} \hat{\dot{I}}_{1t} = 0 \]

\[ \hat{\dot{Q}}_{2t} - \frac{C_2}{\tilde{Q}_2} \hat{\dot{C}}_{2t} - \frac{X_2}{\tilde{Q}_2} \hat{\dot{X}}_{2t} - \frac{I_2}{\tilde{Q}_2} \hat{\dot{I}}_{2t} = 0 \]

\[ \hat{\dot{Q}}_{3t} - \frac{C_3}{\tilde{Q}_3} \hat{\dot{C}}_{3t} - \frac{I_3}{\tilde{Q}_3} \hat{\dot{I}}_{3t} = 0 \]

\[ 0 = \hat{\dot{p}}_{2t} + \hat{\dot{X}}_{2t} - \hat{\dot{p}}_t^S - \hat{\dot{M}}_t^S \]

\[ \frac{1}{M^S} \hat{\dot{M}}_t^S + \frac{M^S}{M^S + M^E} \hat{\dot{M}}_t^S - \frac{E_1}{E_1 + E_2 + E_3} \hat{\dot{E}}_{1t} - \frac{E_2}{E_1 + E_2 + E_3} \hat{\dot{E}}_{2t} - \frac{E_3}{E_1 + E_2 + E_3} \hat{\dot{E}}_{3t} = 0 \]

\[ \hat{\dot{w}}_{1t} = \theta_1 \hat{\dot{w}}_{1,t-1} + (1 - \theta_1) \hat{\dot{w}}_{1t}^D \]

\[ \hat{\dot{w}}_{2t} = \theta_2 \hat{\dot{w}}_{2,t-1} + (1 - \theta_2) \hat{\dot{w}}_{2t}^D \]

\[ \hat{\dot{w}}_{3t} = \theta_3 \hat{\dot{w}}_{3,t-1} + (1 - \theta_3) \hat{\dot{w}}_{3t}^D \]
Table 1. Static cost of the collapse in Soviet trade.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Imports from the USSR</td>
<td>14,816</td>
<td>12,655</td>
</tr>
<tr>
<td>F</td>
<td>Exports to the USSR</td>
<td>16,160</td>
<td>14,324</td>
</tr>
</tbody>
</table>

Change in prices in Soviet trade (%Δ from previous year)

| C        | Export prices | 6.17 | 25.02 | -24.33 |
| B        | Import prices | 22.43 | 12.99 | -5.86 |

| D        | Price premium in Soviet market in 1990 (markup over price available in other markets) | 36 | 36 |
| H        | Change in export volume to USSR | -11.36 | -68.44 |
| J        | Increase in the domestic price of energy | 15.98 | -1.14 |
| K        | Value of energy imports from USSR (at domestic prices) | 7,642 | 6,009 |
| L        | Reduction in energy use by subsidized users | -0.94 | -2.43 |

\[ \text{Market loss effect} = D \times F(-1) \times H \]
\[ \text{Terms of trade effect} = A \times (C - B) \]
\[ \text{Removal of subsidy effect} = \frac{1}{2} \times J \times K \times L \]
\[ \text{Total loss of income} = M + N + R \]

Total loss of income (million USD) = -1,212

Gross Domestic Product (GDP) | 521,021 | 498,067 |
Private sector value added (PSVA) | 389,798 | 356,207 |
Total loss of income

\% of GDP | 0.16% | -0.98% |
\% of PSVA | 0.22% | -1.38% |
Lost ruble surpluses (million Finnish markka) | -7,500 |
Lost ruble surpluses (million USD) | -1,853 |
Total loss of income incl. lost ruble surpluses

\% of GDP | -2.5% |
\% of PSVA | -3.5% |

Panel B:

<table>
<thead>
<tr>
<th>Cumulative 1990-1991 total loss of income</th>
<th>% of GDP</th>
<th>Billion USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poland</td>
<td>-3.5%</td>
<td>-2.20</td>
</tr>
<tr>
<td>Hungary</td>
<td>-7.8%</td>
<td>-1.97</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>-7.5%</td>
<td>-3.40</td>
</tr>
</tbody>
</table>

Note: The cost of the collapsed trade is compute according to the method developed in Rodrik (1994). Estimate of cumulative shocks for Poland, Hungary and Czech Republic are taken from Rodrik (1994). Unless indicated, Finnish exports, imports, value added, and lost ruble reserves are in million of Finnish markka. Sources: Finnish Ministry of Statistics, OECD STAN database.
Table 2. Gross value of product, hours, exports and exports to CMEA prior to collapse of trade.

<table>
<thead>
<tr>
<th>Values in 1988</th>
<th>Gross value of product</th>
<th>Hours</th>
<th>Exports</th>
<th>Exports to CMEA</th>
<th>Exports/ GDP</th>
<th>CMEA Exp/ Total exp</th>
<th>CMEA Exp/ GDP</th>
<th>Hours/ GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food, beverage, tobacco and live animals</td>
<td>47,234</td>
<td>70,731</td>
<td>1,841</td>
<td>338</td>
<td>3.90</td>
<td>18.36</td>
<td>0.72</td>
<td>1.50</td>
</tr>
<tr>
<td>Textiles, Apparel and leather</td>
<td>10,136</td>
<td>55,634</td>
<td>3,411</td>
<td>1,169</td>
<td>33.65</td>
<td>34.27</td>
<td>11.53</td>
<td>5.49</td>
</tr>
<tr>
<td>Wood and wood products</td>
<td>14,593</td>
<td>43,036</td>
<td>2,318</td>
<td>156</td>
<td>15.88</td>
<td>6.73</td>
<td>1.07</td>
<td>2.95</td>
</tr>
<tr>
<td>Paper &amp; paper products, Publish. &amp; printing</td>
<td>59,855</td>
<td>92,365</td>
<td>25,222</td>
<td>2,720</td>
<td>42.14</td>
<td>10.78</td>
<td>4.54</td>
<td>1.54</td>
</tr>
<tr>
<td>Furniture</td>
<td>4,240</td>
<td>18,364</td>
<td>734</td>
<td>61</td>
<td>17.31</td>
<td>8.31</td>
<td>1.44</td>
<td>4.33</td>
</tr>
<tr>
<td>Chem, Petroleum and Rubber, Glass &amp; Clay</td>
<td>38,143</td>
<td>63,502</td>
<td>18,380</td>
<td>1,918</td>
<td>48.19</td>
<td>10.44</td>
<td>5.03</td>
<td>1.66</td>
</tr>
<tr>
<td>Metal and elect' al &amp; instruments</td>
<td>45,914</td>
<td>91,547</td>
<td>15,032</td>
<td>1,883</td>
<td>32.74</td>
<td>12.53</td>
<td>4.10</td>
<td>1.99</td>
</tr>
<tr>
<td>Mach and transport equipment</td>
<td>35,732</td>
<td>94,123</td>
<td>25,879</td>
<td>7,188</td>
<td>72.43</td>
<td>27.78</td>
<td>20.12</td>
<td>2.63</td>
</tr>
<tr>
<td>Other</td>
<td>2,071</td>
<td>8,335</td>
<td>85</td>
<td>0</td>
<td>4.10</td>
<td>0.00</td>
<td>0.00</td>
<td>4.02</td>
</tr>
<tr>
<td>Total</td>
<td>257,918</td>
<td>53,763</td>
<td>92,902</td>
<td>15,433</td>
<td>36.02</td>
<td>16.61</td>
<td>5.98</td>
<td>2.08</td>
</tr>
</tbody>
</table>

Percent change 1988-93

<table>
<thead>
<tr>
<th>Values in 1988</th>
<th>GDP</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food, beverage, tobacco and live animals</td>
<td>4.75</td>
<td>-28.61</td>
</tr>
<tr>
<td>Textiles, Apparel and leather</td>
<td>-37.92</td>
<td>-61.73</td>
</tr>
<tr>
<td>Wood and wood products</td>
<td>4.52</td>
<td>-32.85</td>
</tr>
<tr>
<td>Paper &amp; paper products, Publish. &amp; printing</td>
<td>6.07</td>
<td>-25.10</td>
</tr>
<tr>
<td>Furniture</td>
<td>-27.26</td>
<td>-44.00</td>
</tr>
<tr>
<td>Chem, Petroleum and Rubber, Glass &amp; Clay</td>
<td>14.87</td>
<td>-29.50</td>
</tr>
<tr>
<td>Metal and elect' al &amp; instruments</td>
<td>35.53</td>
<td>-26.55</td>
</tr>
<tr>
<td>Mach and transport equipment</td>
<td>-0.97</td>
<td>-35.80</td>
</tr>
<tr>
<td>Other</td>
<td>19.17</td>
<td>-23.54</td>
</tr>
<tr>
<td>Total</td>
<td>9.14</td>
<td>-33.23</td>
</tr>
</tbody>
</table>

Source: Finnish Ministry of Statistics, authors’ calculations.
## Table 3. Wage bargaining agreements.

<table>
<thead>
<tr>
<th>Year</th>
<th>Agreement</th>
<th>Period of validity</th>
<th>Increase effective from</th>
<th>General Increase</th>
<th>Minimum and low-pay increase%</th>
<th>Average increase(^\text{19})</th>
<th>Reforms Related to Centralized Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>Union-level agreements</td>
<td>2 year</td>
<td>01.03.1988</td>
<td>98-145</td>
<td>5.3</td>
<td></td>
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<td>1990</td>
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Source: Central Organization of Finnish Trade Unions (SAK).

\(^{19}\) Industrial workers.
Figure 1. Real GDP, Investment and Consumption in Finland (1990=100).

Note: The data are from *International Financial Statistics* and are deflated using the consumer price index.

Figure 2. Real GDP in Finland and Eastern Europe (1990=100).

Note: The data are from *International Financial Statistics* and are deflated using the consumer price index.
Figure 3. Soviet and non-Soviet exports.

Note: This figure reports exports by destination, Soviet vs. non-Soviet. Exports are in thousands of fixed 2000 US dollars. For post 1991 years, Soviet Union exports are computed as the sum of exports to the 15 republics of the former Soviet Union. Source: OECD, Finnish Ministry of Statistics, author’s calculations.

Figure 4. Structure of imports from the USSR.

Note: For post 1991 years, Soviet Union exports are computed as the sum of exports to the 15 republics of the former Soviet Union. Source: OECD, Finnish Ministry of Statistics, author’s calculations.
Figure 5. Soviet and non-Soviet exports for selected industries.

Panel A: Cable and wire

Panel B: Railroad equipment

Panel C: Shipbuilding

Panel D: Footwear

Note: This figure reports exports by destination, Soviet vs. non-Soviet. Exports are in thousands of fixed 2000 US dollars. For post 1991 years, Soviet Union exports are computed as the sum of exports to the 15 republics of the former Soviet Union.
Figure 6. Distribution of wage changes by industry.

Note: This figure reports distribution of individual workers’ wages. Vertical axis measures fraction. Horizontal axis measures percent change in wages. Source: Bockerman, Laaksonen, and Vainiomaki (2006).
Figure 7. Aggregate and sectoral series: Deviations from trend.

Note: The figure plots percent deviations from time trend estimated on 1975-1989 data. The deviation is normalized to be zero in 1990.
Figure 8. Macroeconomic aggregates: Simulated response to oil and trade shocks. Baseline calibration.
Figure 9. Soviet sector: Simulated response to oil and trade shocks. Baseline calibration.
Figure 10. Non-Soviet sector: Simulated response to oil and trade shocks. Baseline calibration.
Figure 11. Service sector: Simulated response to oil and trade shocks. Baseline calibration.
Figure 12. Macroeconomic aggregates: Effects of adjustment costs and habit formation.

- **Aggregate: Deviation from trend: Value added**
- **Aggregate: Deviation from trend: Employment**
- **Aggregate: Deviation from trend: Investment**
- **Aggregate: Deviation from trend: Consumption**
- **Aggregate: Deviation from trend: Wage**

Legend:
- **data**
- **baseline model**
- **no investment adj. costs**
- **no habit in consumption**
- **no labor adj. costs**
Figure 13. Macroeconomic aggregates: Effects of production function parameters.

Aggregate: Deviation from trend: Value added

Aggregate: Deviation from trend: Employment

Aggregate: Deviation from trend: Investment

Aggregate: Deviation from trend: Consumption

Aggregate: Deviation from trend: Wage

Legend:
- data
- baseline model
- CES production
- RTS $\gamma = 0.95$
Figure 14. Macroeconomic aggregates: Effects of consumption parameters.
Figure 15. Macroeconomic aggregates: Effects of wage rigidity.

- Aggregate: Deviation from trend: Value added
- Aggregate: Deviation from trend: Employment
- Aggregate: Deviation from trend: Investment
- Aggregate: Deviation from trend: Consumption

Legend:
- data
- baseline model
- fully flexible wages
- fully rigid wages
Figure 16. Macroeconomic aggregates: Interest rate shock.
Figure 17. Oil price shock in 1974.

Note: Solid line is the deviation of real GDP, real consumption, and real investment from the respective linear time trends estimated on 1950-1973 data. Real GDP, real consumption, and real investment (in 2000 prices) series are taken from Penn World Tables. The deviation adjusted to be zero in 1973. Broken line is the model impulse response to 109% increase in the price of oil. Model parameters are calibrated according to their baseline values. See text for further details.
Figure 18. Tax burden.

Note: This figure reports the tax burden on income. Source: OECD, Finnish Ministry of Finance.
Figure 19. Output dynamics in Poland and Hungary.

Note: Solid line is the deviation of real GDP series from the linear time trend estimated on 1970-1989 data. Real GDP (in 2000 prices) series for Hungary and Poland are taken from Penn World Tables. The deviation adjusted to be zero in 1989. Broken line is the model impulse response to collapse of the trade with the USSR. See text for further details.
Appendix Figure 1. Macroeconomic aggregates: Actual series and estimated trend.

Note: The figure reports logs of real value added, real investment, real consumption, hours, and real wages. Solid line is time trend estimated on 1975-1989 data. Broken line is actual series.
Appendix Figure 2. Sectoral dynamics: Actual series and estimated trend.

Note: The figure reports logs of real value added, real investment, real consumption, hours, and real wages. Solid line is time trend estimated on 1975-1989 data. Broken line is actual series.