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THE FINNISH GREAT DEPRESSION: FROM RUSSIA WITH LOVE*

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Current version: July 2008

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 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. Finland and these transition countries show almost identical “U-shaped” dynamics of output in the early 1990s. Yet, as a western democracy with fully developed capital markets and well-functioning legal and political institutions, Finland faced none of the large institutional adjustments experienced in the formerly centrally-planned economies. Thus, by studying the Finnish experience we can isolate the adjustment costs due solely to the collapse of trade from the other burdens of adjustment borne by transition economies. We develop and calibrate a multi-sector dynamic general equilibrium model of the Finnish economy and show that the collapse of Soviet-Finnish trade account for 90 percent of the output drop that occurred during Finland’s Great Depression.

JEL: E32, F41, P2.

Keywords: business cycles, depression, trade, Soviet, reallocation, multi-sector model.

* The authors would like to thank participants of seminars at the University of Michigan, the University of California at Davis, University of California at Berkeley, “Macroeconomics across Time and Space” at the Federal Reserve Bank of Philadelphia, Western Michigan University, Society for Economic Dynamics, Olivier Coibin, Wolfgang Keller, Lee Ohanian, Kei-Mu Yi, Jeff Smith, and Jing Zhang.

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, 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 currency 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 Finnish Great Depression – the one advanced in this paper - 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 between the USSR and Finland skewed Finnish production toward particular labor-intensive sectors and effectively allowed Finland to export non-competitive, labor-intensive products in exchange for energy imports at an overvalued exchange rate. We develop a multisector dynamic general equilibrium model with wage rigidities that can account for several of the key features of the Finnish Great Depression as the economy's response to the collapse of trade with the Soviet Union. The dynamic model generates large declines in aggregate output, consumption and employment, and replicates the dynamics of the sector devoted to Soviet trade, the non-Soviet sector of tradable goods, and the nontradables sector. The deep,

persistent recession generated by the model follows in particular from a protracted period of U-shaped adjustment in employment (with employment falling sharply in the early stages of transition and recovering slowly in the later stages). In turn, this adjustment is caused by the elimination of the implicit subsidy in energy imports from the Soviet Union and, more importantly, by the sudden redundancy of the Soviet-oriented sector and its capital stock. Rigidity in real wages prevented labor from reallocating across sectors and accounts for the persistence of the contraction.

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, Slovakia, Bulgaria and Finland. The figure captures the familiar “U-shaped” path for output characteristic of transition economies (Blanchard and Kremer 1997, Roland and Verdier 1999). 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 7 to 21 percent of the level of GDP in 1990. The most remarkable feature of Figure 2 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.¹ Finland experienced the full force of the Soviet trade shock, but as a western democracy with fully developed capital markets and well-functioning legal and political institutions, faced none of the institutional adjustments experienced in the formerly centrally-planned economies. Thus, by studying the Finnish experience we can isolate the adjustment costs due solely 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

¹ 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 these 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. In Appendix Table 1, we use Rodrik's method to compute the static cost of the Soviet trade collapse for Finland. The size of the shock is comparable to the Soviet trade shocks experienced by Eastern European transition countries.

and Finland. We will argue that these arrangements caused Finland to specialize in sectors that were inefficient from an economic point of view. In Section III, we develop the dynamic model designed to capture the basic features of Finland's production and trade with the rest of the world. In Section IV 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, as once-and-for-all unanticipated shocks in a deterministic environment, and compare the model's dynamics 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 is left to be explained by other factors. We find that up to 90 percent of the output drop in Finland can be explained by the collapse of Soviet trade.

In section V, we compare our trade theory of the Finnish recession with alternative explanations proposed in the literature. In section VI, 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 VII.

I Finnish-Soviet Trade

The trade relationship between Finland and the Soviet Union began with heavy Finnish reparations to the USSR between 1944 and 1952. In the complicated aftermath of WWII, Finland managed to retain its political independence from the USSR, but entered into a series of highly regulated trade agreements with its Soviet neighbor, similar to the trade patterns that evolved between the USSR and other East European economies. These agreements established the volume and composition of trade between the two countries and in the case of Finland evolved over time into the barter of Finnish manufactured goods for Soviet crude oil. The agreements were negotiated at five-year intervals with some intervening adjustments to respond to changes in economic conditions, such as fluctuations in the market value of oil. 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.² 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.

By 1975, the USSR was Finland's most important trading partner. Figure 3 plots Soviet and non-Soviet exports over the 1975-2003 period.³ During the early to mid-1980s, the USSR accounted for 20-25 percent of Finnish trade flows. Thereafter, the volume of trade with the Soviet Union began to gradually decline until the collapse of the trade agreement in December 1990. Part of the decline during the 1980s was an endogenous contraction, resulting from falling oil prices. The decline was also a consequence of the reforms under Perestroika, which attempted to decentralize Soviet decision making but made it difficult for Finnish trade authorities to identify those with real authority on the Soviet end of the bargain.⁴ The trade regime fully collapsed and all contracts with the Soviet Union were cancelled on December 18, 1990.

Composition of trade

Finland's dependence on the Soviet Union is reflected not only in the volume of trade, but also in the composition of the bilateral trade flow. 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*, 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

² 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.

³ The bulk of Finland's east-bloc oriented trade was directly with the USSR, although in some years the bilateral agreements were modified to include the export of Finnish goods to other CMEA member countries.

⁴ See "Perestroika enters Finland, a bit bumpily," *The New York Times*, January 16, 1989.

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 experienced in most other industrialized countries. As oil prices rose, Finland was able to expand employment and production in those sectors exporting to the USSR 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 a key export market as well as an 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.⁵ 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.

Profitability of Soviet trade

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 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

⁵ For a discussion of the trading system of Hungary, Austria, Finland and Yugoslavia with the Soviet Union see Richter (1990) and Oblath and Pete (1990).

did not compete directly with products traded in western markets. Based on commodity data at the seven-digit level, Kajaste (1992) estimates that the prices of exports to the Soviet Union was at least 9.5 percent higher than the prices 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-level of disaggregation for 1990. Using unit prices of non-CMEA exports to quantities of Soviet exports, we find that Soviet exports evaluated at non-CMEA export prices are 36 percent smaller than the value of Soviet exports. 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 a 36 percent discount. In the model developed in Section 2 below, we assume a 10 to 30 percent market on exports to the USSR relative to goods exported to Western markets.⁶

To assess the degree of specialization of good destined for the USSR, 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 percent of all exports of this good went to socialist countries. At the more detailed 7-digit level, Kajaste (1992) identifies 133 items with a Soviet export share exceeding 90 percent. These items constituted approximately 40 percent of exports to the USSR. Kajaste (1992) reports that because of the 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 firms' capacity developed for trading with the USSR became more or less obsolete overnight.^{7,8}

⁶ The decision to subsidize Finnish firms was clearly a political one, as the USSR certainly could have bought comparable goods at a lower price on the world market. 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." Soviet leaders viewed the trade agreement with Finland not only as a source of modern Western technology but also as a laboratory for cooperation between capitalist and socialist countries. 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).

⁷ The fact that Finnish exports to the USSR could have had a limited success in the West was clearly understood at the time. 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

In addition to the significant markup associated with 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 a 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.”⁹

A final, and somewhat overlooked, advantage of trade enjoyed by firms export to the Soviet Union emerged in the 1980s, when the Reagan administration tightened export controls against the Soviet bloc, with particular focus on blocking the transfer of technology. Finnish companies had, in effect, a temporary monopoly over technology exports to the Soviets.¹⁰ Two companies in particular, Rauma-Repola and Nokia, the 6th and 5th largest companies in Finland in terms of 1985 net sales, benefited from their unique geo-political position. Rauma-Repola had a contract with the USSR to develop a deep-sea submersible, that would allow the

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).

⁸ Another important aspect of trade with the USSR was industry 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 percent of all exports, the fifty largest for 78.7 percent, 116 largest for 90 percent (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.

⁹ Nokia was a major exporter of power and relay cables to the USSR in the 1960s, and eventually of telecommunications equipment in the 1970s and 1980s. In his history of Nokia, Haikio (2001) notes that trade with the Soviet Union, while somewhat cumbersome and bureaucratic, had its advantages. “The Soviet Union paid reliably and promptly, ordered long lines of productions and was predictable in its order volumes. The profits were quite high as the prices were linked to international market prices that were often dictated by monopolies within closed western markets.” (p. 67).

¹⁰ Because Finland was not a member of NATO, it was exempted from the embargo on the USSR. Finland’s exploitation of this loophole to export certain products to the USSR heightened diplomatic tensions with the US.

Soviet navy to explore virtually all of the ocean floor. The American government initially allowed the project to move forward, under the misguided view that the company would be incapable of developing the technology. When the company succeeded, the Finnish and US governments negotiated the sale of two of the submersibles in exchange for further tightening of other Finnish technology exports.¹¹ Nokia similarly walked a fine line in international politics in its export of telecommunications equipment to the USSR. It was given permission to sell some lines of technology, but withheld product source codes from the Soviets, preventing them from modifying the equipment for alternative uses (Haikio, 2001). Nokia scored a major publicity coup in 1987 by photographing Mikhail Gorbachev placing a call on Nokia's newest mobile phone (See also Haikio, 2001).

Pervasiveness of Soviet trade

Table 1 shows exports to the USSR by sector, as a share of sectoral exports and as a share of sectoral value added. The table focuses on the year 1988, before the uncertainties of Perestroika began to disrupt trade contracts. Among the sectors with heaviest Soviet-trade exposure were textiles, textile products, leather and footwear, with Soviet exports accounting for 29 percent of exports and 34 percent of value added. Machinery and equipment also had significant Soviet exposure at both the aggregate and disaggregated level. The sector with the heaviest exposure is transport equipment, and this exposure is further concentrated in shipbuilding (85 percent of exports designated for the USSR and 225 percent of value added) and railroad equipment (86 percent of exports to USSR and 103 percent of value added). A message of Table 1 is that while some manufacturing sectors were particularly specialized in goods destined for Soviet market, no sector was fully isolated from the loss of Soviet trade.

One of the challenges in calibrating the model to the data is that the pervasiveness of Soviet exports throughout the manufacturing sector makes it difficult to separate out a “Soviet” sector from a “non-Soviet” sector. In the model, the trade shock will be concentrated in sectors with heaviest exposure to Soviet trade. In the data, the “Soviet-exposed” sector will be defined as a weighted index of industrial sectors. We define ω_i^x as the share of exports of

¹¹ For a more detailed discussion, see Jensen-Eriksen (2006).

industry i at time t to the Soviet Union in total exports of industry i . Let Q_{it} be value added (or any other the variable of interest) in industry i at time t . Then we compute value added in the Soviet-exposed sector as $Q_t^S = \sum_i \omega_{it}^X Q_{it}$ and correspondingly the non-Soviet-exposed sector is $Q_t^{NS} = \sum_i (1 - \omega_{it}^X) Q_{it}$. We treat services as a separate sector producing non-tradable goods. We allow the weights, ω_{it}^X , to change over the 1989-1992 period. The relative size of the Soviet sector will therefore decline automatically as trade with the USSR collapses.

We provide details on data sources and construction of sectors in the data Appendix. We take 1989 as the “pre-collapse” benchmark year. Based on this definition, Table 2 shows the share of the Soviet sector in total value added, capital/labor ratios, employment and output shares as well as other descriptive statistics in the base year.

Impact and timing of the collapse

Figure 5 shows the exports of four industries that sent a significant share of their exports to the USSR (Cable and wire with the 1990 Soviet share of total exports of 30 percent; Railroad equipments with 96 percent; Shipbuilding with 74 percent; and Footwear with 43 percent). In general, the loss of Soviet exports caused total exports to fall, suggesting that the goods were not redirected to other countries after the collapse of Soviet trade. The example of the railroad equipment industry is particularly illuminating. The Soviet Union had a railway system designed for a gauge different from the rail systems operating in other European countries, and different from that in Finland itself. 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 countries. Footwear and textile exports were also specifically designed for the Soviet market, in some cases for the military.¹² Even for industries that had some export recovery (e.g., shipbuilding), the loss of the Soviet market was painful as it involved major transformations in product lines. The strategy of “icebreakers for the communists, luxury liners for the capitalists” meant that production facilities specialized for Soviet production had

¹² A Finnish shoe manufacturer, Urho Viljanmaa Oy, notes on its current website that “[a]lthough the company worked as a subcontractor, manufacturing small numbers of some shoes for export to the Soviet Union, it never became a major market. Strategically, this saved the company because it did not suffer from the collapse of sales to the Soviet Union in the early 1990s as much as most of the companies in the shoe industry in Finland.”

to be shut down. The entire industry reorganized in the early 1990s with a loss of many thousands of jobs.¹³

A key assumption that will be embedded in the model is that the collapse of Soviet trade was largely unanticipated. It was clear that the Soviet Union was under distress in the late 1980s, and that some Finnish companies faced difficulty in their trade dealings with the Soviets. However, news articles and policy analyses from the period suggest that Finnish government officials and firms remained optimistic about the future of trade with the USSR. In its report on the “Finnish Economy to 1994,” the Ministry of Finance wrote in 1989 that the government anticipated no major deviations in the volume or the composition of trade from the agreed-upon five year plan.¹⁴ As late as 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 in December, earlier than was originally planned. A representative of the central bank suggested that it was still possible that the system would be reformed, and not fully dismantled. Even the telecommunications division at Nokia remained confident that sales to the Soviet Union would continue at their mid-1980 levels. In 1990 the division’s forecasts for 1991 were optimistic, projecting January/February 1991 sales at 121 million markka (23 million euros). Sales came in at just 2 million markka (340,000 euros) and the top management conceded that trade to the Soviet Union was a thing of the past and that their entire sales strategy had to be revamped (Haikio, 2001).

¹³ Sutela (1991) provides a case study of the shipbuilding industry in Finland. Finnish shipbuilders had supplied the Soviet Union since 1940s. The major companies were Valmet (state-owned), Repola, Wartsila, and Hollming. Hollming was the only one of these firms specialized in shipbuilding. The 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 the 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.

¹⁴ The report stated, “According to the principles agreed on last autumn, the level of exports [to the USSR] cannot deviate from this [target] notably, except as a result of the clearing-account balance burden due to earlier credit granting. As for the composition of exports what can be assumed at this point is primarily that shipbuilding industry is likely to play a rather central role also in the future. ... It may be legitimate to proceed on the assumption that the volume of imports can be maintained at its current level in the next five-year framework agreement too.” Finnish Ministry of Finance (1989).

Labor Markets

A critical friction in our model, necessary to slow the transition dynamics following the collapse of Soviet trade, is the rigidity of labor markets. The 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.¹⁵ 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, 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 1993.¹⁶ Strikingly, the fraction of workers with no wage change reached 75 percent. 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) who cite Finland as the country with one of the greatest downward wage rigidities.

As we will report later, the dynamics of wages at the macro level are 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

¹⁵ See Snellman (2005) for a more detailed description of the wage bargaining process in Finland.

¹⁶ 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).

suggests that very sluggish adjustment of wages at the aggregate level reflects genuine wage rigidity rather than compositional changes in employment. We conclude that wage stickiness was a prominent feature of the Finnish labor market during the depression.

Summary

In the next section we develop a model of the Finnish economy that captures the key features of the trading relationship between the Soviet Union and Finland. These features include the volume of trade, the particular composition of trade (barter of manufactures for oil), an overvalued terms of trade, low elasticity of substitution between goods destined for the Soviet market and western markets, and rigid labor markets. We will treat the collapse of Soviet trade as an unanticipated shock. We will then compare the macroeconomic time series produced by the model in the aftermath of the collapse of Soviet trade with Finnish data.

II Model

We model the Finnish economy as a small open economy with three sectors. The first sector (non-Soviet) produces a traded good consumed at home and sold abroad in western markets. The second sector (Soviet) produces a good that can be consumed at home or sold exclusively to the Soviet Union. The third sector (services) produces non-tradable goods.

Households

The representative household chooses a lifetime plan for consumption and leisure to maximize utility $U \equiv \sum_{t=0}^{\infty} \beta^t U(G_t, L_{1t}, L_{2t}, L_{3t})$, where G is a CES consumption aggregator over

four consumption goods: C_{1t} , consumption the good produced by sector 1, C_{2t} , consumption of the good produced by the sector with Soviet exposure, C_{3t} , consumption of services and C_{4t} , a good imported from the western markets.¹⁷ We assume that the consumption aggregator

is given by $G_t = \left\{ \zeta_1 \bar{C}_{1t}^{\rho_c} + \zeta_2 \bar{C}_{2t}^{\rho_c} + \zeta_3 \bar{C}_{3t}^{\rho_c} + \zeta_4 \bar{C}_{4t}^{\rho_c} \right\}^{1/\rho_c}$ where $1/(1-\rho_c)$ is the elasticity of substitution in consumption, ζ_j are weights in the consumption aggregator. In a more general specification we allow for habit formation in consumption.

¹⁷ The fourth consumption good plays no role in the dynamics but allows us to calibrate the model to reflect positive imports from Western markets.

To eliminate wealth effects on labor supply, we follow Greenwood, Hercowitz and Huffman (1988) and assume $U(G_t, L_{1t}, L_{2t}, L_{3t}) = \frac{1}{1-\sigma} \left(G_t - \frac{\chi_1}{\eta_1+1} L_{1t}^{\eta_1+1} - \frac{\chi_2}{\eta_2+1} L_{2t}^{\eta_2+1} - \frac{\chi_3}{\eta_3+1} L_{3t}^{\eta_3+1} \right)^{(1-\sigma)}$ where σ is the elasticity of intertemporal substitution, $1/\eta_j$ is the Frisch elasticity of labor supply in sector j and χ_j is the scale of disutility from working in sector j . In the benchmark version of the model we assume that labor is sector specific and hence wages are not generally equalized across sectors. Aggregate labor supply is $L_t = L_{1t} + L_{2t} + L_{3t}$. In robustness exercises we examine the case of a high elasticity of substitution between labor services allocated to different sectors.

Households face the following budget constraint:

$$w_{1t}L_{1t} + w_{2t}L_{2t} + w_{3t}L_{3t} + B_{t+1} - R_t B_t - C_{1t} - p_{2t}C_{2t} - p_{3t}C_{3t} - p_{4t}C_{4t} = 0,$$

where w_j is the wage rate in sector $j = 1, 2, 3$, B_t is a one-period discount bond traded on international markets at the gross world interest rate of R .¹⁸

Production

Firms in all three sectors use inputs of capital, labor and energy to produce final output. The problem faced by a representative firm in each industry is to choose factor inputs to maximize profits. In sector $j = 1, 2, 3$, a representative firm solves the following problem:

$$\sum_{t=0}^{\infty} \frac{1}{\prod_{s=0}^t R_s} \left(p_{jt} Q_{jt} - p_t^E E_{jt} - w_{jt} L_{jt} - p_{jt} (K_{jt} - (1-\delta)K_{j,t-1}) - p_{jt} \frac{\phi_j}{2} \left(\frac{K_{jt}}{K_{j,t-1}} - 1 \right)^2 K_{j,t-1} \right),$$

where Q is physical output, K is the capital stock, L is the labor input, E is the energy input, I is investment, and p_j is the price of goods in sector j (we take good 1 as numeraire so $p_{1t} = 1$) and p^E is the price of energy. In a more general specification we allow for adjustment costs in investment and labor.

Production functions are given by $Q_{jt} = Z_{jt} \min \left\{ a_{jE} E_{jt}, (\alpha_{jK} K_{j,t-1}^{\rho_P} + \alpha_{jL} L_{jt}^{\rho_P})^{\gamma_j / \rho_P} \right\}$, for $j=1, 2, 3$, where a_{jE} is the energy requirement in sector j , $1/(1-\rho_P)$ is the elasticity of

¹⁸ In some specifications of the numerical simulations we allow for returns to scale to be less than one, where economic profits in sector j are $\pi_{jt} = Y_{jt} - w_{jt}L_{jt} - (\delta + R)p_{jt}K_{j,t-1}$. Profits in that case are rebated to the household.

substitution between capital and labor, α_{jK} and α_{jL} are weights in the capital-labor aggregator, Z_j is the level of technology in sector j , and γ_j is returns to scale in sector j . At an optimum, no input is wasted so $a_{jE}E_{jt} = Q_{jt}$. For convenience define value added as $Y_{jt} \equiv p_{jt}Q_{jt} - p_t^E E_{jt} = (p_{jt} - \frac{p_t^E}{a_{jE}})Q_{jt}$ and the corresponding value added function as $F_j(K_{j,t-1}, L_{jt}, p_{jt}, p_t^E) \equiv Y_{jt}$. Note that for simplicity the three sectors do not have direct linkages via input-output relationships.

Market clearing conditions

In each sector, output is consumed, invested or exported:

$$Q_{1t} - C_{1t} - I_{1t} - X_{1t} = 0,$$

In the non-Soviet sector, output is consumed by domestic consumers, invested in sector 1 or exported to western markets in exchange for energy imports, M^* , at world prices p^* and good C_4 :

$$TB_t = X_{1t} - p_t^* M_t^* - p_{4t} C_{4t} = B_{t+1} - R_t B_t$$

In the Soviet sector, a fraction of output is consumed by domestic consumers, invested in sector 2, or sold to the Soviet market in exchange for energy:

$$Q_{2t} - C_{2t} - I_{2t} - X_{2t} = 0,$$

To capture the clearing system in the Finnish-Soviet trade, we assume that the trade with the Soviet Union is balanced at all times:

$$p_{2t} X_{2t} - p_t^S M_t^S = 0,$$

where p_t^S is the price of oil from the Soviet union. M_t^S is imports of energy from the USSR. Values of p_t^S and M_t^S are fixed, set by the five-year agreements between Finland and the USSR.

We assume that Finland produces no energy domestically and energy is not storable so that import of energy is equal to consumption of energy:

$$M_t^* + M_t^S - (E_{1t} + E_{2t} + E_{3t}) = 0.$$

Wage determination

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:

$$w_{1t} = \theta_1 w_{1,t-1} + (1 - \theta_1) w_{1t}^D,$$

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

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

where the parameter θ governs the degree of wage stickiness, w^D is the reservation wage given by the household labor supply. 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 θ , $w_j^D = w_j$ in the pre-Soviet-collapse steady state.

Calibration

The model is calibrated at a quarterly frequency. The quarterly depreciation rate of capital is the same across sectors and equal to $\delta = 0.025$ (i.e., approximately 10 percent at the annual frequency). The discount factor is $\beta = 0.99$ so that the real rate or return is 4 percent per annum, assuming the standard stationarity condition that equates the rate of interest with the rate of time preference. We also calibrate the intertemporal elasticity of substitution as $\sigma = 2$, the standard value in the RBC literature.

Micro level studies favor very large values for η , so that the labor supply elasticity $1/\eta$ is small. On the other hand, macro level models need relatively large labor supply elasticity to generate large movements in labor. Recently, Hall (2007) provided empirical evidence indicating that the elasticity is about 0.91 in the United States. In line with this evidence, we set $\eta = 1$ in the benchmark case, but also examine alternative parameter values allowing for more substitutability across labor uses.

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 α_{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 the 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 percent, which implies that returns to scale are 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 markup on exports to the Soviet Union relative to the world price of oil was 10 percent, and our estimates are 36 percent. We examine a range of markups of 10 to 30 percent.

Because energy and value added are Leontieff complements, the energy requirement in the non-Soviet sector is given by $a_1 = Q_1 / E_1 = p_1 Q_1 / p^E E_1$. 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 6.7. For other sectors, we cannot make this calculation directly because it depends on prices determined in equilibrium. We can impute the relative prices using cost shares for labor, capital labor ratios and relative wages and then compute energy intensity for the Soviet and service sectors: $a_2 = 6.542$ and $a_3 = 41.923$.

Using information on employment shares and relative wages, we can calculate ratios $\chi_2/\chi_1 = 4.098$ and $\chi_3/\chi_1 = 0.323$. Because utility is Cobb-Douglas, we set $p_4 = 1$ without loss of generality. The remaining parameters (χ_1, Z_2, Z_3) are calibrated to match the following facts: trade with the USSR was 17.5 percent of total exports and 60 percent of output in the Soviet sector, the non-Soviet consumes 78 percent of energy, the Soviet sector consumes 4.8 percent of energy.¹⁹ Since more than 90 percent of energy was imported from the USSR we assume that in the pre-Soviet-collapse period no energy was imported from other countries. We assume small to moderate adjustment costs in capital stock ($\phi_1 = \phi_2 = \phi_3 = 1$).

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 Appendix Figure 3). In light of these facts, we set $\theta_1 = \theta_2 = \theta_3 = 0.99$.

Numerical simulation of benchmark economy

In this section we study the response of the Finnish economy to the collapse of trade with the Soviet Union, modeled as a once-and-for-all unanticipated shock in a deterministic environment. As we explained, this shock had two major components: First, Finland lost one of its major export markets and because of the specialized trade 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_t^S , and hence X_t^2 to zero.²⁰ Second, the Soviet Union subsidized Finland with cheap energy. Our discussion in previous sections suggests that the subsidy was at least 10 percent of the oil price. The 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 $p^E = 1$

¹⁹ With Cobb-Douglas consumption aggregator, p_4 can be normalized to be equal to one.

²⁰ 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).

to $p^E = 1.1$. We hit our model economy with these two shocks as of the initial date $t=0$ and compute the resulting transitional dynamics.²¹

Figure 7 plots actual and simulated responses for key macroeconomic variables. The model can capture the dynamics of output well in terms of magnitude. The model correctly predicts 20 percent fall of output below the trend. The simulated series for wages is reasonably close to the actual dynamics. The model can explain most of the declines in consumption and employment. For instance, consumption in the model falls by as much as 20 percent while the contraction in the data was about 22 percent below the trend. Likewise, the model predicts a 25 percent contraction in labor supply, which is close to the 24 percent contraction in the data. However, the model predicts a recovery in consumption to 5 percent below the trend while consumption in the data does not seem to recover and stays 20-22 percent permanently below trend. The model also predicts a moderate recovery in employment that is somewhat stronger than what is observed in the data.

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

Figure 8 though Figure 10 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, there are some quantitative departures. For example, output in the non-Soviet sector in 1992 falls by 3 percent in the model and by 20 percent 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

²¹ Following Mendoza and Tesar (1998), we used shooting and linearization around the post-Soviet-collapse steady state to adjust transitional dynamics for steady state changes in the net foreign asset position. The quantitative results were similar to the results reported in the paper.

service sectors, but we are less successful at matching the response of the non-Soviet sector. Specifically, the model understates the contraction in the non-Soviet sector.

It may seem surprising that the collapse of Soviet trade, which accounted for only about 5 to 6 percent of employment and value added, can produce a significant contraction of output at the aggregate level (almost 20 percent). The key to understanding this result is the combined effect of wage rigidity and the role of nontradables. Consider first a two-sector model, with only the Soviet and non-Soviet sectors. In this economy, the collapse of trade with the Soviets would put pressure on factors to shift from the Soviet to non-Soviet sector. This happens for two reasons: first, because the relative price of the Soviet-goods falls, and second, all of Finland's energy needs now to be financed by exports of the non-Soviet good. If factors are perfectly immobile, the maximum output effect is a fall of about 5 percent. To the extent that factors can adjust, the decline in output will be smaller.

What happens when there are nontraded goods in the economy? The trade collapse causes the relative price of oil to rise, increasing production costs in both the non-Soviet and nontraded goods sectors. In addition, the collapse of demand in the Soviet sector reduces income and hence the demand for all other goods. These two effects together result in a decline in the relative price of nontraded goods, and a decline in output. Rigid wages amplify the contraction in demand in the short run. As consumers purchase fewer goods, firms demand less labor which entails further contraction of demand and the spiral continues. In summary, a combination of higher costs of producing goods as well as a fall in demand magnified by rigid wages leads to large short-run multipliers on the initial shocks.

To assess the separate contribution of oil price and trade shocks, we perturb the economy with one shock at a time and plot the resulting transitional dynamics of aggregate variables (see Figure 7). The economy's response to an oil price shock is much smaller than the response of the economy to losing the trade relationship with the USSR. In addition, the response to the oil price shock tends to produce an *expansion* of the Soviet sector, because larger exports to the USSR increase the amount of oil that can be imported and thus help offset the effect of the higher price of energy. This is consistent with the Finnish experience when oil prices increased in late 1970s and early 1980s (Figure 8). By contrast, the trade shock leads to an expansion in the non-Soviet sector (Figure 9). In general, the oil and pure

trade shocks push the Soviet and non-Soviet sectors in different directions, but the two shocks are contractionary for the services sector (Figure 10).

In the remainder of the section we vary parameter values to study the 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 11).²² However, adding adjustment costs and habit formation improves the model's ability to match the timing of troughs. Our qualitative results are not sensitive to changes in the production function parameters (Figure 12). Decreasing the elasticity of substitution between capital and labor from one to 0.5 amplifies responses of all variables.²³ 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 13). 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 14). In the case with fully flexible wages, the recession is short and shallow. For example, employment and consumption fall only by 5 percent and there is little dynamics after the first year. Likewise, output and investment decline only by 10 percent. 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 percent decline. At the sectoral dimension, fully flexible wages fail to capture the contraction across sectors. In particular, the 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

²² We assume small to moderate adjustment costs in 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 $h_1= h_2=h_3=0.8$.

²³ In the richer model with habit formation and additional adjustment costs in the flow of investment and labor higher elasticity has only small effect on the impulse responses.

relatively more productive non-Soviet sector. In contrast, when wages are rigid, the 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 occurs 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 the 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 would be more confident about the conclusions derived 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 the early 1970s.

Although most economies experienced the oil 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 percent.

Figure 15 plots the model's transitional dynamics in response to the oil price shock and the dynamics of actual output, consumption and investment. Again, we detrend the data to remove secular movements in macroeconomic variables. The model broadly matches the response of the Finnish 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.

III Alternative explanations of the depression

In this section, we briefly discuss several alternative theories of the Finnish Great Depression. Obviously, such a major downturn in economic activity probably had more than one cause. Hence, our aim here is simply to compare our explanation with the alternatives and provide a sense of potential quantitative importance.

In a recent paper, Conesa, Kehoe and Ruhl (2007) argue that the depression was caused by an adverse shock to total factor productivity (TFP) and increased labor taxes. However, sources of TFP shocks are, as always, difficult to identify. Still, we can reconcile the findings in Conesa et al (2007) with our story. Note that oil price shocks work like a technology shock since an increase in oil prices reduce firms' profit margins (provided there is a sufficiently small substitutability of energy input). Thus what Conesa et al. interpret as a TFP shock could be partly capturing the energy price shock (a similar argument was made for the case of the United States by Finn (2000)). Indeed, measured productivity in our model is $(1 - \frac{P_i^E}{a_{jE}P_{jt}})Z_j$ which decreases as the energy price rises. Likewise, one may expect that unobserved factor utilization would lead to decreased measured productivity.

Regarding the possibility of labor tax increases, we were unable to find information on any changes in tax rates in the Finnish press and legislation. Moreover, various measures of the tax burden on labor earnings exhibit very little variation over the 1990s (see Figure 16), and changes in the tax laws enacted to bring the Finnish legislation in line with European standards were too minor to be important for aggregate dynamics. However, we may explain the 'source' of the labor-tax-like effects that Conesa et al. (2007) emphasize as follows.

Labor taxes drive a wedge between the wage paid by firms and that received by workers, but wage rigidities can produce similar outcomes. In an equilibrium without frictions, the wage received by workers is equal to their reservation wage, i.e. $w_{jt} = w_{jt}^D$. If

wages are rigid, however, the reservation wage is not generally equal to the wage actually received. 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 wages and the reservation wages, in particular $w_{jt} > w_{jt}^D$. Moreover, if firms stay on their labor demand curve, they will cut employment. Because of these arguments, if we want to reconcile decreased employment (as observed in the data) with fully flexible wages (as assumed by Conesa et al. (2007)), we would need to interpret this situation as if there was a ‘labor tax’ shock. In other words, one can interpret $w_{jt} > w_{jt}^D$ as arising from a labor tax τ such that $w_{jt} > (1 - \tau)w_{jt} = w_{jt}^D$ 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, and one that seems to be in line with empirical evidence.

Another popular explanation of the Finnish Great 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 a 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.²⁴ 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 the dynamics observed 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 17. Clearly, an increase in the interest rate depresses economic activity at the aggregate level and improves the fit of the

²⁴ One can alternatively interpret the interest rate shock as an exogenous change due to German reunification, which happened around the same time.

model at the sectoral level when combined with other shocks. Specifically, interest rate shocks help the model to match the downturn in the non-Soviet sector. By itself, however, the shock has small quantitative effects for variables other than investment. In addition, investment tends to overshoot after the period of high interest rates. We conclude from these results that a credit crunch could be a useful complement to our story.

An alternative way to assess the importance of the collapse in the Soviet-Finnish trade in accounting for the Finnish recession is to compare the output dynamics in Sweden and Finland. Both countries had practically analogous institutions and experienced similar and almost simultaneous sequence of events (including currency and financial crises) in the late 1980s and early 1990s with the only major difference being that Sweden had miniscule trade with USSR when compared to Finland's trade. In a sense, Sweden could be used as a counterfactual for what should have happened to Finland if it did not trade so much with the USSR. Figure 20 plots the time series of percent deviations of output from linear time trend (estimated on 1970-1990 data) for Finland and Sweden. Note that at the trough of the recession the output drop in Finland was about 15 percent deeper than in Sweden. If we take this difference as a measure of the contribution of the Soviet trade collapse to the Finnish depression, then the magnitude of the contribution is broadly in line with impulse responses in our model. Hence, the observed difference between output paths in Sweden and Finland is consistent with our argument that the decline of the Soviet-Finnish trade explains a significant chunk of the downturn in Finland.

IV 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 a “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 the 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 percent 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.²⁵

Our simulation results suggest that the elimination of the energy subsidy and trade relationship 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

²⁵ 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 were able to redirect trade from socialist partners to EU and other industrialized countries. Instead, it is likely to imply that countries continued to have a comparative advantage in producing certain broadly defined types of goods.

believe that real wages were strongly inflexible because inflation was high and variable.²⁶ 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.

To support our theory of contraction in the transition countries, we need to compare simulated transitional dynamics from the model (calibrated for these countries) with the data responses at the aggregate and sectoral levels (also for these countries). 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.²⁷ These modifications in

²⁶ Although wage arrears were another source of wage flexibility, wage arrears were largely limited to former Soviet Union republics and had little impact in other Eastern European countries.

²⁷ 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.

ξ s as well as adjustments in χ_2 are necessary to match the size of the Soviet sector, which we set to 20-25 percent in Poland and Hungary, and the share of Soviet exports in total exports, which we set to 30 percent in both countries.²⁸

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 percent more expensive relative to the pre-collapse price. Poland was less dependent on energy imports from the USSR and, consequently, we assume a 15 percent 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 percent for Hungary and by 45-50 percent for Poland.²⁹ Consequently, we set trade shocks to 65 percent and 50 percent. Finally, we assume that the collapse of the Soviet trade occurred (or started to occur) in 1990 rather than 1991.

Figure 18 plots the dynamics of real GDP in the model and data in response 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.

We also conjecture that misallocation of resources in the former Soviet Union could have played an important role in the dramatic output decline in the early 1990s. Indeed, an enormous fraction of Soviet economy was militarized (15-20 percent of GNP according to

²⁸ 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.

²⁹ Export statistics are taken from IMF Direction of Trade Statistics (DOTS) database. Other data sources (OECD, national statistical offices) report similar magnitudes.

various estimates)³⁰ and had only limited ability to switch production to non-military goods. For example, All-Russian Scientific Research Institute for Experimental Physics (the developer of nuclear and thermonuclear weapons) was supposed to be organizing the series production of pipe connections for the milk lines of dairy plants (Menshikov, 2000). A tremendous shift in demand towards consumer goods meant a gigantic reallocation of resources which was probably even more painful and costly than in other countries of the socialist camp.³¹ In other words, the shock was internal rather than external. In addition, many relatively energy-poor Soviet republics (e.g., Ukraine) had to buy oil and gas at new higher prices (the energy subsidy was partially or fully removed shortly after the collapse of the USSR) which combined with the loss of demand from other Soviet republics resembles the shock experienced by other Eastern European countries and Finland.

V Concluding Remarks

In this paper we analyze the effects on the Finnish economy of the surge in energy prices and sudden redundancy of Soviet-oriented manufacturing caused by the collapse of the Soviet Union. We find that the Great Depression experienced by the Finnish economy in 1991-1993 can be explained to a large extent by this trade shock. Given that post-socialist economies exhibited output dynamics and Soviet trade patterns similar to those observed in Finland, we argue that the economic collapse of formerly socialist economies in the early 1990s could also have been mainly due to the same 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 the full amount of contraction in transition countries and Finland. The Finnish experience can also shed some light on the post-WWII contractions in

³⁰ See, for example, U.S. Arms Control and Disarmament Agency (1995), Noren (1995), Steiner and Holzman (1990). Perevalov (2000) estimates that about 9 million people (a third of employed in industry) were working for military oriented enterprises.

³¹ Perevalov (2000), Menshikov (2000) and others report that military orders declines by almost 70 percent between 1990 and 1992. In 1992 alone, military production fell by 42 percent which constituted about a half of production decline in the military industry between 1990 and 1997. Cumulatively, between 1990 and 1997 arm procurements fell by 90 percent, employment in formerly military oriented firms fell by up to 3.5 million people, more than 54 percent of production capacity of defense firms had to be retooled.

Argentina and New Zealand and possibly other historical episodes of rapid reductions in exports and subsequent collapse of output.

The natural experiment of the Soviet-Finish 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 exporting 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

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: Detrending and construction of sectoral data

Since our study does not focus on long-run growth, we study macroeconomic aggregates filtering out their long-run trend. 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 was 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 Appendix Figure 3. Note that the detrended series exhibit a much stronger decline than the raw series. For example, real value added falls by 13 percent, while filtered real value added decreases by almost 20 percent. 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 firm 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 so we construct the Soviet sector using industry level data. The risk of working with industry data is that there could be 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 construct the Soviet sector with the following approach.

Define ω_{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 the variable of interest) in industry i at time t . Then we compute value added in the Soviet sector as $Q_t^S = \sum_i \omega_{it}^X Q_{it}$ and correspondingly the non-Soviet sector is $Q_t^{NS} = \sum_i (1 - \omega_{it}^X) Q_{it}$. To control for entry and exit

of firms and products, we assume that the 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 the Soviet sector share at 1988 values for the period before 1988 to eliminate the 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 ω_{it}^x to vary only between 1988 and 1992. We refer to the resulting weights as ‘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 trend component using a linear filter estimated on 1975-1989 data (Appendix Figure 3). 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.

Appendix: Log-linearized model

Hats denote percent deviations from steady state. This model allows for adjustment costs in investment and labor as well as habit formation in consumption. This generalized model has the following modifications in the consumer and firm problems. Specifically, we assume that the consumption aggregator is given by $G_t = \{\zeta_1 \bar{C}_{1t}^{\rho_c} + \zeta_2 \bar{C}_{2t}^{\rho_c} + \zeta_3 \bar{C}_{3t}^{\rho_c} + \zeta_4 \bar{C}_{4t}^{\rho_c}\}^{1/\rho_c}$ where $1/(1-\rho_c)$ is the elasticity of substitution in consumption, ζ_j are weights in the consumption aggregator, $\bar{C}_{jt} = \frac{1}{1-h_j} C_{jt} - \frac{h_j}{1-h_j} C_{j,t-1}$ is the habit-adjusted consumption for good j , and parameter h_j describes habit in consuming good j . Firm's objective (profit) function is

$$\sum_{t=0}^{\infty} \frac{1}{\prod_{s=0}^t R_s} \left(p_{jt} Q_{jt} - p_t^E E_{jt} - w_{jt} L_{jt} - p_{jt} I_{jt} - p_{jt} \left\{ \frac{\phi_j}{2} \left(\frac{K_{jt}}{K_{j,t-1}} - 1 \right)^2 K_{j,t-1} + \frac{\psi_j}{2} \left(\frac{I_{jt}}{I_{j,t-1}} - 1 \right)^2 I_{j,t-1} + \frac{\lambda_j}{2} \left(\frac{L_{jt}}{L_{j,t-1}} - 1 \right)^2 L_{j,t-1} \right\} \right),$$

where the parameters $\phi_j, \psi_j, \lambda_j$ are adjustment cost coefficients on capital, investment and labor respectively.

Household problem

$$\begin{aligned} \frac{\partial \ell}{\partial C_{1t}} &= \hat{U}'_{C_1} - \hat{\mu}_{1t} = 0 \\ \frac{\partial \ell}{\partial C_{2t}} &= \hat{U}'_{C_2} - \hat{p}_{2t} - \hat{\mu}_{1t} = 0 \\ \frac{\partial \ell}{\partial C_{3t}} &= \hat{U}'_{C_3} - \hat{p}_{3t} - \hat{\mu}_{1t} = 0 \\ \frac{\partial \ell}{\partial C_{4t}} &= \hat{U}'_{C_4} - \hat{p}_{4t} - \hat{\mu}_{1t} = 0 \\ \frac{\partial \ell}{\partial L_{1t}} &= \hat{U}'_{L_1} + \hat{w}_{1t}^D + \hat{\mu}_{1t} = 0 \\ \frac{\partial \ell}{\partial L_{2t}} &= \hat{U}'_{L_2} + \hat{w}_{2t}^D + \hat{\mu}_{1t} = 0 \\ \frac{\partial \ell}{\partial L_{3t}} &= \hat{U}'_{L_3} + \hat{w}_{3t}^D + \hat{\mu}_{1t} = 0 \\ -\hat{S}_t + (1+r)\hat{S}_{t-1} + (1+r)\hat{R}_t + \frac{w_1 L_1}{S} (\hat{w}_{1t} + \hat{L}_{1t}) + \frac{w_2 L_2}{S} (\hat{w}_{2t} + \hat{L}_{2t}) + \frac{w_3 L_3}{S} (\hat{w}_{3t} + \hat{L}_{3t}) \\ &\quad - \frac{c_1}{S} \hat{C}_{1t} - \frac{p_2 C_2}{S} (\hat{p}_{2t} + \hat{C}_{2t}) - \frac{p_3 C_3}{S} (\hat{p}_{3t} + \hat{C}_{3t}) - \frac{p_4 C_4}{S} (\hat{p}_{4t} + \hat{C}_{4t}) + \frac{\pi_1}{S} \hat{\pi}_{1t} + \frac{\pi_2}{S} \hat{\pi}_{2t} + \frac{\pi_3}{S} \hat{\pi}_{3t} = 0 \\ -\hat{L}_t + \frac{L_1}{L_1+L_2+L_3} \hat{L}_{1t} + \frac{L_2}{L_1+L_2+L_3} \hat{L}_{2t} + \frac{L_3}{L_1+L_2+L_3} \hat{L}_{3t} &= 0 \\ \frac{\partial \ell}{\partial S_t} &= -\hat{\mu}_{1t} + \hat{\mu}_{1,t+1} + \hat{R}_{t+1} = 0. \end{aligned}$$

Utility

$$U'_{C_{jt}} = \underbrace{\left(G_t - \frac{\lambda_1}{\eta_1+1} L_{1t}^{\eta_1+1} - \frac{\lambda_2}{\eta_2+1} L_{2t}^{\eta_2+1} - \frac{\lambda_3}{\eta_3+1} L_{3t}^{\eta_3+1} \right)^{-\sigma}}_{U_0} G'_{C_{jt}} = U_{0t} G'_{C_{jt}} = \frac{1}{1-h_j} U_{0t} s_{C_{jt}} G_t / \bar{C}_{1t} - \frac{\beta h_j}{1-h_j} U_{0,t+1} s_{C_{j,t+1}} G_{t+1} / \bar{C}_{1t+1}.$$

Note that in steady state $\bar{C}_j = C_j$ and $U'_{C_{jt}} = \frac{1-\beta h_j}{1-h_j} U_0 s_{C_j} G / \bar{C}_j$.

$\hat{U}_0 = -\sigma(s_G \hat{G}_t + s_{L_1}(1+\eta_1)\hat{L}_{1t} + s_{L_2}(1+\eta_2)\hat{L}_{2t} + s_{L_3}(1+\eta_3)\hat{L}_{3t})$ where

$s_G = G_t / (G_t - \frac{\chi_1}{\eta_1+1} L_{1t}^{\eta_1+1} - \frac{\chi_2}{\eta_2+1} L_{2t}^{\eta_2+1} - \frac{\chi_3}{\eta_3+1} L_{3t}^{\eta_3+1})$ and

$s_{L_j} = -\frac{\chi_j}{\eta_j+1} L_{jt}^{\eta_j+1} / (G_t - \frac{\chi_1}{\eta_1+1} L_{1t}^{\eta_1+1} - \frac{\chi_2}{\eta_2+1} L_{2t}^{\eta_2+1} - \frac{\chi_3}{\eta_3+1} L_{3t}^{\eta_3+1})$.

Hence $\hat{G}_t = s_{C_1} \hat{C}_{1t} + s_{C_2} \hat{C}_{2t} + s_{C_3} \hat{C}_{3t} + s_{C_4} \hat{C}_{4t}$ and

$\hat{s}_{C_{jt}} = \rho_C \left[(1-s_{C_1}) \hat{C}_{1t} - s_{C_2} \hat{C}_{2t} - s_{C_3} \hat{C}_{3t} - s_{C_4} \hat{C}_{4t} \right] = \rho_C \hat{C}_{1t} - \rho_C \hat{G}_t$ where $\hat{C}_{1t} = \frac{1}{1-h_1} \hat{C}_{1t} - \frac{h_1}{1-h_1} \hat{C}_{1,t-1}$.

It follows that

$$\begin{aligned} \hat{U}'_{C_{jt}} &= \frac{1}{1-\beta h_j} (\hat{U}_{0t} + \hat{s}_{C_{jt}} + \hat{G}_t - \hat{C}_{jt}) - \frac{\beta h_j}{1-\beta h_j} (\hat{U}_{0,t+1} + \hat{s}_{C_{j,t+1}} + \hat{G}_{t+1} - \hat{C}_{j,t+1}) = \\ &= \frac{1}{1-\beta h_j} (\hat{U}_{0t} + (1-\rho_C) \hat{G}_t + (\rho_C - 1) \hat{C}_{jt}) - \frac{\beta h_j}{1-\beta h_j} (\hat{U}_{0,t+1} + (1-\rho_C) \hat{G}_{t+1} + (\rho_C - 1) \hat{C}_{j,t+1}) \\ U'_{L_j} &= \underbrace{\left(G - \frac{\chi_1}{\eta_1+1} L_{1t}^{\eta_1+1} - \frac{\chi_2}{\eta_2+1} L_{2t}^{\eta_2+1} - \frac{\chi_3}{\eta_3+1} L_{3t}^{\eta_3+1} \right)^{-\sigma}}_{U_0} (-\chi_j L_{jt}^{\eta_j}) = -U_0 \chi_j L_{jt}^{\eta_j} \end{aligned}$$

$$\hat{U}'_{L_j} = -\hat{U}_0 - \eta_j \hat{L}_{jt}.$$

Firm's problem in the non-Soviet sector

$$\begin{aligned} \frac{\partial \ell}{\partial K_{1t}} &= -\hat{v}_{1t} - \hat{K}_{1,t+1} + \frac{F'_{1K}}{F_{1K}+(1-\delta)} \hat{F}'_{1K,t+1} + \frac{\phi}{F'_{1K}+(1-\delta)} \hat{K}_{1,t+1} - \frac{\phi}{F'_{1K}+(1-\delta)} \hat{K}_{1t} \\ \frac{\partial \ell}{\partial I_{1t}} &= -\hat{v}_{1t} + \phi_1 (\hat{K}_{1t} - \hat{K}_{1,t-1}) + \psi_1 (\hat{I}_{1t} - \hat{I}_{1,t-1}) - \beta \psi_1 (\hat{I}_{1,t+1} - \hat{I}_{1t}) = 0 \\ \frac{\partial \ell}{\partial L_{1t}} &= \hat{F}'_{1L,t} - \hat{w}_{1t} - \frac{\lambda_1}{w_1} (\hat{L}_{1t} - \hat{L}_{1,t-1}) + \frac{\beta \lambda_1}{w_1} (\hat{L}_{1,t+1} - \hat{L}_{1t}) = 0 \\ \hat{\pi}_{1t} &= \frac{Y_{1t}}{\pi_1} Y_{1t} - \frac{w_1 L_{1t}}{\pi_1} (\hat{w}_{1t} + \hat{L}_{1t}) - \frac{(\delta+r)K_{1t}}{\pi_1} \hat{K}_{1,t-1} \\ \hat{Q}_{1t} &= \gamma_1 s_{1K} \hat{K}_{1,t-1} + \gamma_1 s_{1L} \hat{L}_{1t} \\ \hat{F}'_{1L} &= \hat{s}_{1L,t} + \hat{Y}_{1t} - \hat{L}_{1t} = \rho_P \left[-s_{1L} \hat{L}_{1t} - s_{1K} \hat{K}_{1,t-1} \right] + \hat{Y}_{1t} + (\rho_P - 1) \hat{L}_{1t} \\ F'_{1K} &= \hat{s}_{1K,t} + \hat{Y}_{1t} - \hat{K}_{1,t-1} = \rho_P \left[-s_{1L} \hat{L}_{1t} - s_{1K} \hat{K}_{1,t-1} \right] + \hat{Y}_{1t} + (\rho_P - 1) \hat{K}_{1,t-1} \\ \hat{Y}_{1t} &= \hat{Q}_{1t} - \frac{p^E/a_{1E}}{1-p^E/a_{1E}} \hat{p}_t^E \\ \hat{E}_{1t} &= \hat{Q}_{1t} \\ -\hat{K}_{1t} + (1-\delta) \hat{K}_{1,t-1} + \hat{I}_{1t} &= 0 \end{aligned}$$

Firm's problem in the Soviet sector

$$\begin{aligned} \frac{\partial \ell}{\partial K_{2t}} &= -\hat{v}_{2t} - \hat{K}_{2,t+1} + \frac{F'_{2K}}{F'_{2K}+p_2(1-\delta)} \hat{F}'_{2K,t+1} + \frac{p_2(1-\delta)}{F'_{2K}+p_2(1-\delta)} \hat{v}_{2,t+1} + \frac{p_2 \phi_2 \delta}{F'_{2K}+p_2(1-\delta)} \hat{K}_{2,t+1} - \frac{p_2 \phi_2 \delta}{F'_{2K}+p_2(1-\delta)} \hat{K}_{2t} \\ \frac{\partial \ell}{\partial I_{2t}} &= -\hat{v}_{2t} + \hat{p}_{2t} + \phi_2 (\hat{K}_{2t} - \hat{K}_{2,t-1}) + \psi_2 (\hat{I}_{2t} - \hat{I}_{2,t-1}) - \beta \psi_2 (\hat{I}_{2,t+1} - \hat{I}_{2t}) = 0 \\ \frac{\partial \ell}{\partial L_{2t}} &= \hat{F}'_{2L,t} - \hat{w}_{2t} - \frac{p_2 \lambda_2}{w_2} (\hat{L}_{2t} - \hat{L}_{2,t-1}) + \frac{\beta p_2 \lambda_2}{w_2} (\hat{L}_{2,t+1} - \hat{L}_{2t}) = 0 \\ \hat{\pi}_{2t} &= \frac{Y_{2t}}{\pi_2} Y_{2t} - \frac{w_2 L_{2t}}{\pi_2} (\hat{w}_{2t} + \hat{L}_{2t}) - \frac{(\delta+r)K_{2t} p_2}{\pi_2} (\hat{p}_{2t} + \hat{K}_{2,t-1}) \end{aligned}$$

$$\begin{aligned}
\hat{Q}_{2t} &= \gamma_2 s_{2K} \hat{K}_{2,t-1} + \gamma_2 s_{2L} \hat{L}_{2t} \\
\hat{F}'_{2L} &= \hat{s}_{2L,t} + \hat{Y}_{2t} - \hat{L}_{2t} = \rho_P \left[-s_{2L} \hat{L}_{2t} - s_{2K} \hat{K}_{2,t-1} \right] + \hat{Y}_{2t} + (\rho_P - 1) \hat{L}_{2t} \\
\hat{F}'_{2K} &= \hat{s}_{2K,t} + \hat{Y}_{2t} - \hat{K}_{2,t-1} = \rho_P \left[-s_{2L} \hat{L}_{2t} - s_{2K} \hat{K}_{2,t-1} \right] + \hat{Y}_{2t} + (\rho_P - 1) \hat{K}_{2,t-1} \\
\hat{Y}_{2t} &= \hat{Q}_{2t} + \frac{p_2}{p_2 - p^E/a_{2E}} \hat{p}_{2t} - \frac{p^E/a_{2E}}{p_2 - p^E/a_{2E}} \hat{p}_t^E \\
\hat{E}_{2t} &= \hat{Q}_{2t} \\
-\hat{K}_{2t} + (1 - \delta) \hat{K}_{2,t-1} + \hat{I}_{2t} &= 0
\end{aligned}$$

Firm's problem in the Service sector

$$\begin{aligned}
\frac{\partial \ell}{\partial K_{3t}} &= -\hat{U}_{3t} - \hat{R}_{t+1} + \frac{F'_{3K}}{F_{3K} + p_3(1-\delta)} \hat{F}'_{3K,t+1} + \frac{p_3(1-\delta)}{F_{3K} + p_3(1-\delta)} \hat{U}_{3,t+1} + \frac{p_3 \phi_3 \delta}{F_{3K} + p_3(1-\delta)} \hat{K}_{3,t+1} - \frac{p_3 \phi_3 \delta}{F_{3K} + p_3(1-\delta)} \hat{K}_{3t} \\
\frac{\partial \ell}{\partial I_{3t}} &= -\hat{U}_{3t} + \hat{p}_{3t} + \phi_3 (\hat{K}_{3t} - \hat{K}_{3,t-1}) + \psi_3 (\hat{I}_{3t} - \hat{I}_{3,t-1}) - \beta \psi_3 (\hat{I}_{3,t+1} - \hat{I}_{3t}) = 0 \\
\frac{\partial \ell}{\partial L_{3t}} &= \hat{F}'_{3L} - \hat{w}_{3t} - \frac{p_3 \lambda_3}{w_3} (\hat{L}_{3t} - \hat{L}_{3,t-1}) + \frac{\beta p_3 \lambda_3}{w_3} (\hat{L}_{3,t+1} - \hat{L}_{3t}) = 0 \\
\hat{\pi}_{3t} &= \frac{Y_3}{\pi_3} Y_{3t} - \frac{w_3 L_3}{\pi_3} (\hat{w}_{3t} + \hat{L}_{3t}) - \frac{(\delta+r)K_3 p_3}{\pi_3} (\hat{p}_{3t} + \hat{K}_{3,t-1}) \\
\hat{Q}_{3t} &= \gamma_3 s_{3K} \hat{K}_{3,t-1} + \gamma_3 s_{3L} \hat{L}_{3t} \\
\hat{F}'_{3L} &= \hat{s}_{3L,t} + \hat{Y}_{3t} - \hat{L}_{3t} = \rho_P \left[-s_{3L} \hat{L}_{3t} - s_{3K} \hat{K}_{3,t-1} \right] + \hat{Y}_{3t} + (\rho_P - 1) \hat{L}_{3t} \\
\hat{F}'_{3K} &= \hat{s}_{3K,t} + \hat{Y}_{3t} - \hat{K}_{3,t-1} = \rho_P \left[-s_{3L} \hat{L}_{3t} - s_{3K} \hat{K}_{3,t-1} \right] + \hat{Y}_{3t} + (\rho_P - 1) \hat{K}_{3,t-1} \\
\hat{Y}_{3t} &= \hat{Q}_{3t} + \frac{p_3}{p_3 - p^E/a_{3E}} \hat{p}_{3t} - \frac{p^E/a_{3E}}{p_3 - p^E/a_{3E}} \hat{p}_t^E \\
\hat{E}_{3t} &= \hat{Q}_{3t} \\
-\hat{K}_{3t} + (1 - \delta) \hat{K}_{3,t-1} + \hat{I}_{3t} &= 0
\end{aligned}$$

General equilibrium

$$\begin{aligned}
\hat{Q}_{1t} - \frac{C_1}{Q_1} \hat{C}_{1t} - \frac{X_1}{Q_1} \hat{X}_{1t} - \frac{I_1}{Q_1} \hat{I}_{1t} &= 0 \\
\hat{Q}_{2t} - \frac{C_2}{Q_2} \hat{C}_{2t} - \frac{X_2}{Q_2} \hat{X}_{2t} - \frac{I_2}{Q_2} \hat{I}_{2t} &= 0 \\
\hat{Q}_{3t} - \frac{C_3}{Q_3} \hat{C}_{3t} - \frac{I_3}{Q_3} \hat{I}_{3t} &= 0 \\
0 &= \hat{p}_{2t} + \hat{X}_{2t} - \hat{p}_t^S - \hat{M}_t^S \\
\frac{1}{M^S} \hat{M}_t^* + \frac{M^S}{M^* + M^S} \hat{M}_t^S - \frac{E_1}{E_1 + E_2 + E_3} \hat{E}_{1t} - \frac{E_2}{E_1 + E_2 + E_3} \hat{E}_{2t} - \frac{E_3}{E_1 + E_2 + E_3} \hat{E}_{3t} &= 0 \\
\hat{w}_{1t} &= \theta_1 \hat{w}_{1,t-1} + (1 - \theta_1) \hat{w}_{1t}^D \\
\hat{w}_{2t} &= \theta_2 \hat{w}_{2,t-1} + (1 - \theta_2) \hat{w}_{2t}^D \\
\hat{w}_{3t} &= \theta_3 \hat{w}_{3,t-1} + (1 - \theta_3) \hat{w}_{3t}^D
\end{aligned}$$

Table 1. Exports to USSR by sector, 1988.

| | Exports to USSR as share of sectoral exports | Exports to USSR as share of sectoral value added | Share of total value added |
|--|---|--|-------------------------------|
| GRAND TOTAL | 0.19 | 0.06 | |
| AGRICULTURE, HUNTING, FORESTRY AND FISHING | 0.03 | 0.00 | 0.058 |
| MINING AND QUARRYING | 0.03 | 0.01 | 0.004 |
| TOTAL MANUFACTURING | 0.19 | 0.24 | 0.242 |
| <i>of which</i> | | | |
| Food products, beverages and tobacco | 0.27 | 0.06 | 0.027 |
| Textiles, textile products, leather and footwear | 0.29 | 0.34 | 0.012 |
| Wood and products of wood and cork | 0.07 | 0.12 | 0.014 |
| Pulp, paper, paper products, printing and publishing | 0.13 | 0.22 | 0.059 |
| Chemical, rubber, plastics and fuel products | 0.15 | 0.17 | 0.025 |
| Other non-metallic mineral products | 0.15 | 0.05 | 0.011 |
| Machinery and equipment | 0.22 | 0.26 | 0.050 |
| Machinery and equipment, n.e.c. | 0.22 | 0.26 | 0.029 |
| Electrical and optical equipment | 0.21 | 0.26 | 0.022 |
| Transport equipment | 0.53 | 1.42 | 0.011 |
| Motor vehicles, trailers and semi-trailers | 0.09 | 0.23 | 0.005 |
| Other transport equipment | 0.84 | 2.24 | 0.007 |
| Building and repairing of ships and boats | 0.85 | 3.34 | 0.004 |
| Aircraft and spacecraft | 0.02 | 0.01 | 0.001 |
| Railroad equipment and transport equipment n.e.c. | 0.86 | 1.03 | 0.002 |
| Manufacturing nec | 0.06 | 0.03 | 0.009 |

Source: Finnish Ministry of Statistics, authors' calculations.

Table 2. Descriptive statistics for Soviet, non-Soviet and service sectors.

| | Soviet sector | Non-Soviet sector | Service sector |
|-------------------------------------|---------------|-------------------|----------------|
| Labor cost share | 0.630 | 0.570 | 0.630 |
| Wages relative to Non-Soviet Sector | 0.983 | 1.000 | 0.914 |
| Capital to labor ratio | 39.711 | 57.499 | 73.855 |
| Share of employment | 0.055 | 0.233 | 0.712 |
| Share of value added | 0.056 | 0.269 | 0.675 |
| Share of consumed energy | 0.048 | 0.780 | 0.172 |
| Share of exports in total exports | 0.175 | 0.815 | - |
| Ratio of energy cost to value added | 0.160 | 0.060 | 0.022 |
| Ratio of exports to value added | 0.470 | 0.420 | - |

Note: the table reports moments of the data for sectors constructed as described in Appendix. Capital to labor ratio is computed by dividing capital stock (computed using perpetual inventory with annual depreciation rate of 10 percent) by hours of work.

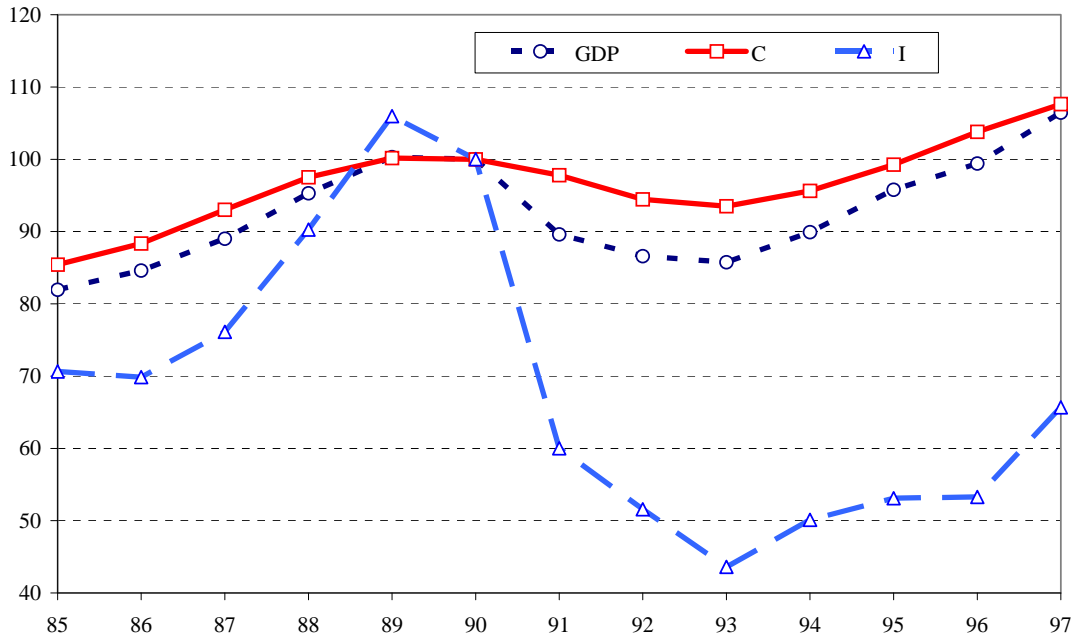
Table 3. Wage bargaining agreements.

| Year | Agreement | Period of validity | Increase effective from | General Increase | | Minimum and low-pay increase % | Average increase ³² % | Reforms Related to Centralized Agreement |
|------|---|--------------------|---|----------------------|----------|--------------------------------|----------------------------------|---|
| | | | | % | p/hour | | | |
| 1988 | Union-level agreements | 2 year | 01.03.1988 | | 98-145 | | 5.3 | |
| 1989 | Combined economic and incomes policy settlement | 1 year | 01.03.1989 | min. 1 | 40 | 0.1% | 3.6 | – employees' real disposable income to be increased by 2.5 % – earnings development guarantee of 70 p above the agreed increase paid in addition to the general and equality raise |
| 1990 | Kallio 15.01.1990 | 2 year | 01.03.1990 01.10.1990 | min. 0.7 min. 0.7 | 30 30 | 0.4% | 5.4 | – state measures, including tax revision – target for growth in employees' real disposable incomes 1990 - 91 4.5% – earnings development guarantee III/89 - III/90 4% above agreed increase |
| 1991 | 2nd phase 15.11.1990 | | 01.05.1991 | min. 0.9 | 50 | 0.3% | 1.7 | – shop stewards agreement – working time issues – adult education, housing and social policy measures |
| 1992 | Ihalainen-Kahri 29.11.1991 | 2 year | Present agreement prolonged to 31.11.1993 | 0 | 0 | 0 | 0.2 | – financing of employment pensions and the employees' contribution – government measures including maintaining |
| 1993 | Ihalainen-Kahri 2nd phase 30.11.1992 | | | 0 | 0 | 0 | 0 | – the level of unemployment benefits – development of agreements' system |
| 1994 | Union-level agreements | 1 year | 1.11.1993 | | | | 3.2 | |
| 1995 | Union-level agreements | 1-2 year | | | | | 5.2 | |
| 1996 | Economic, Employment and Labor Market Policy | 2 year | 1.11.1995 | min. 1.8 | 105 | | 2.1 | – indexation clause – earnings development guarantee 1996 and 1997 – working life development |
| | Agreement 1996 - 97 10.9.1995 | | 1.10.1996 | min. 1.3 | 65 | 0.3% | 1.7 | – state measures i.e. concerning taxation and unemployment security |
| 1997 | 2nd phase | | | | | | 0.0 | |
| 1998 | Incomes policy agreement 1998 - 1999 12.12.1997 | 2 year | 1.1.1998 | min. 1.6 | 85 p | 0.3% | 2.5 | – indexation clause – earnings development examination – quality of working life – taxation measures |
| 1999 | 2nd phase | | 1.1.1999 | min. 1.6 | 85 p | | 1.7 | |

Source: Central Organization of Finnish Trade Unions (SAK).

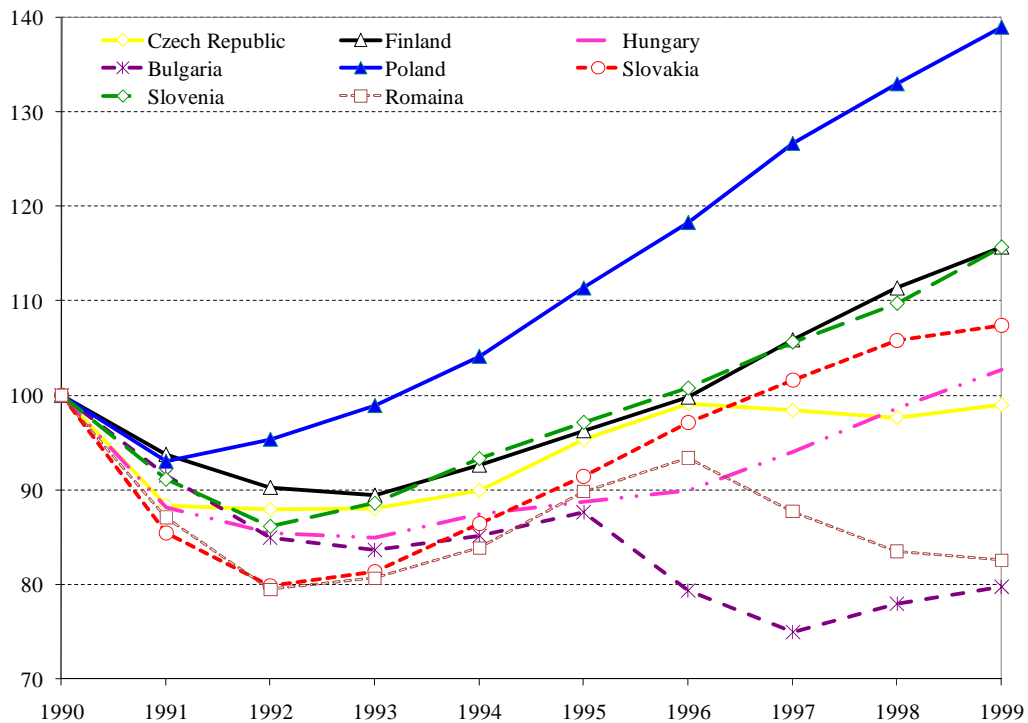
³² Industrial workers.

Figure 1. Real GDP, Investment and Consumption in Finland (1990=100).



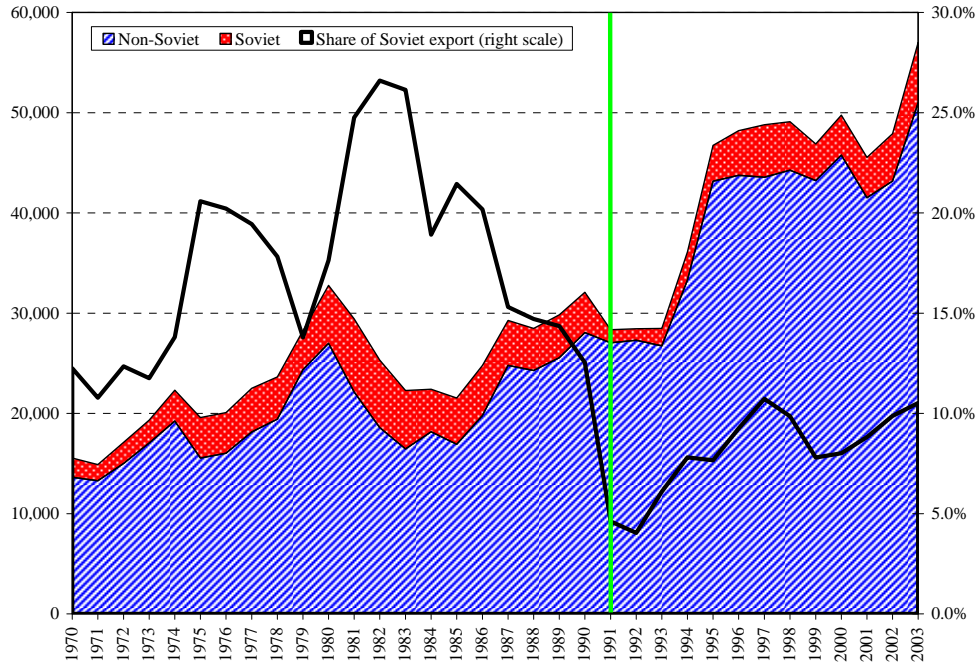
Note: The data are from *International Financial Statistics* and are deflated using the consumer price index.

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



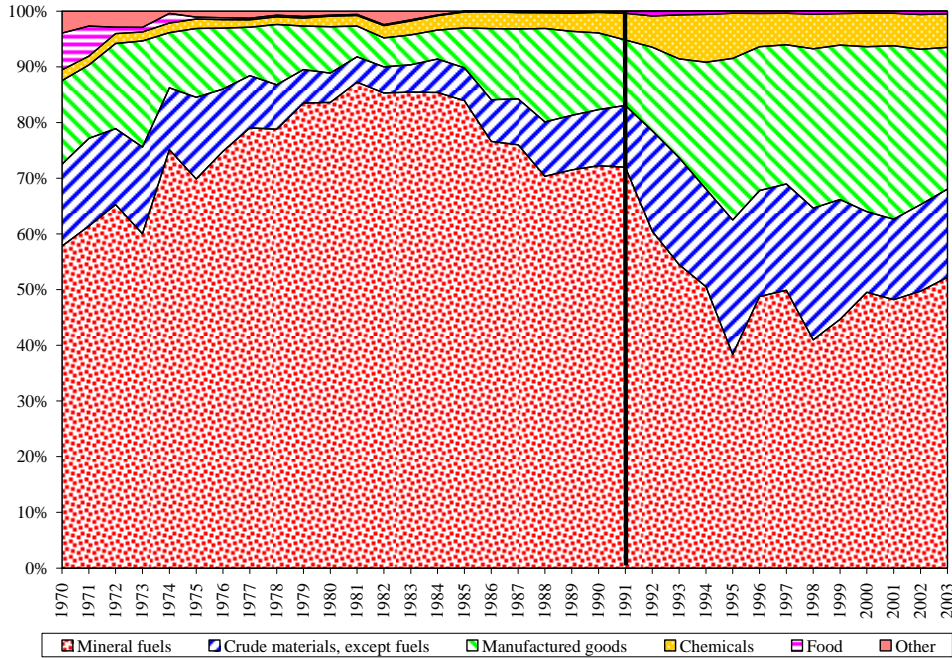
Note: National Accounts Estimates of Main Aggregates, United Nations Statistics Division.

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.

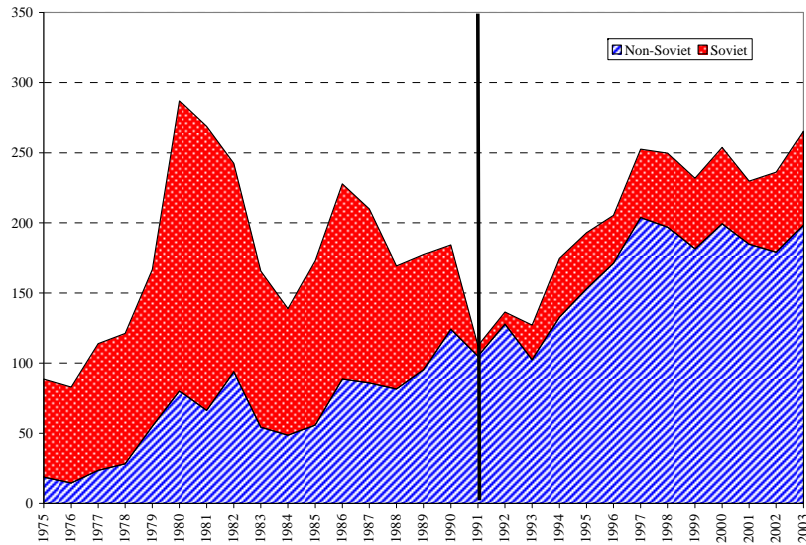
Figure 4. Structure of imports from the USSR.



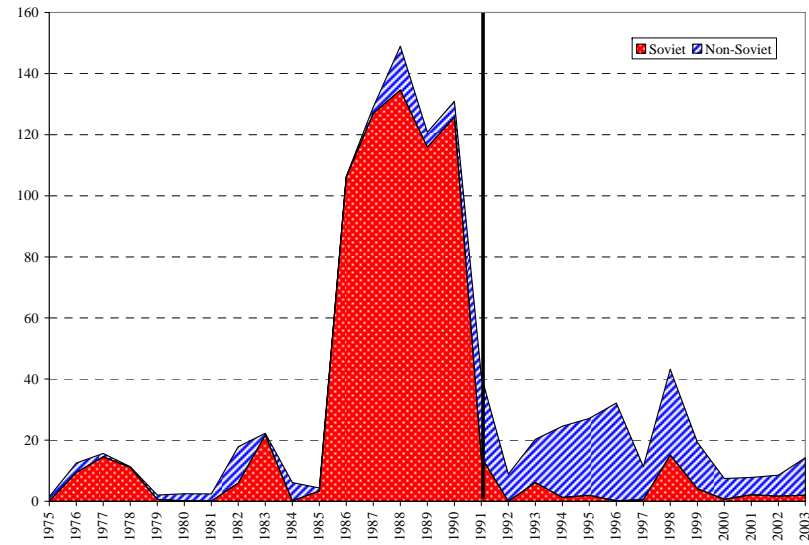
Note: For post 1991 years, Soviet Union exports are computed as the sum of exports to the 15 republics of the former Soviet Union. Source: OECD, Finnish Ministry of Statistics, author's calculations.

Figure 5. Soviet and non-Soviet exports for selected industries.

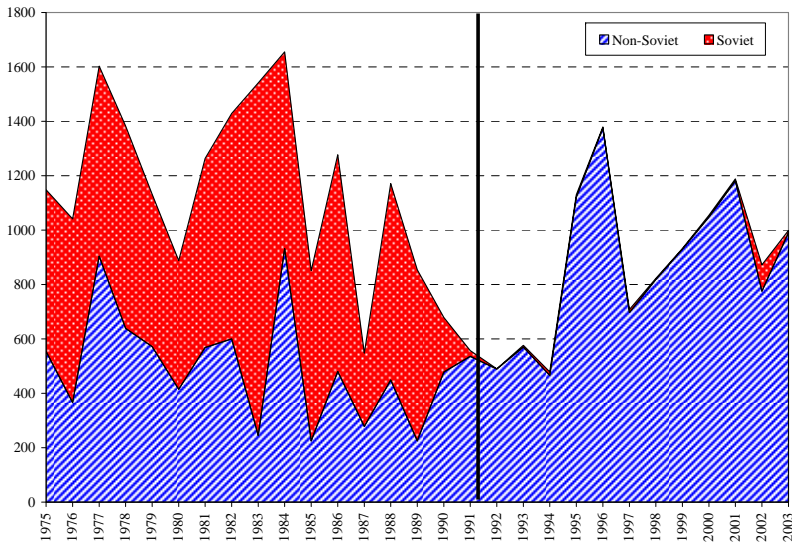
Panel A: Cable and wire



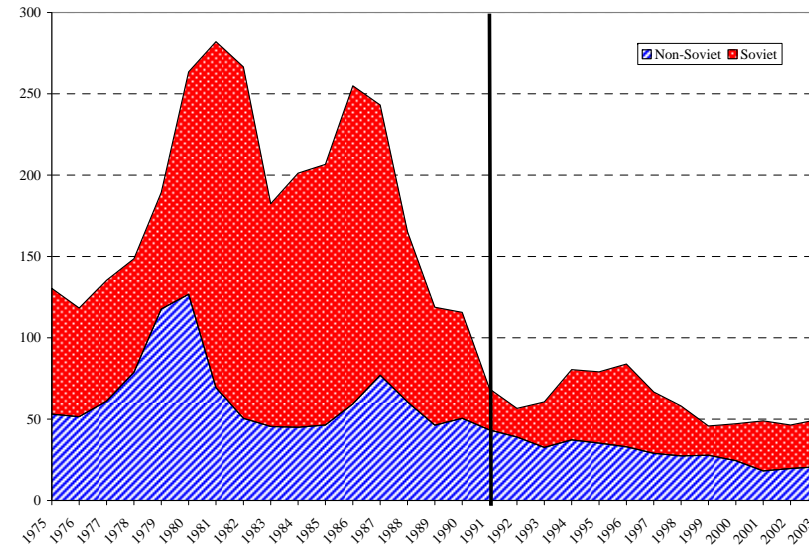
Panel B: Railroad equipment



Panel C: Shipbuilding

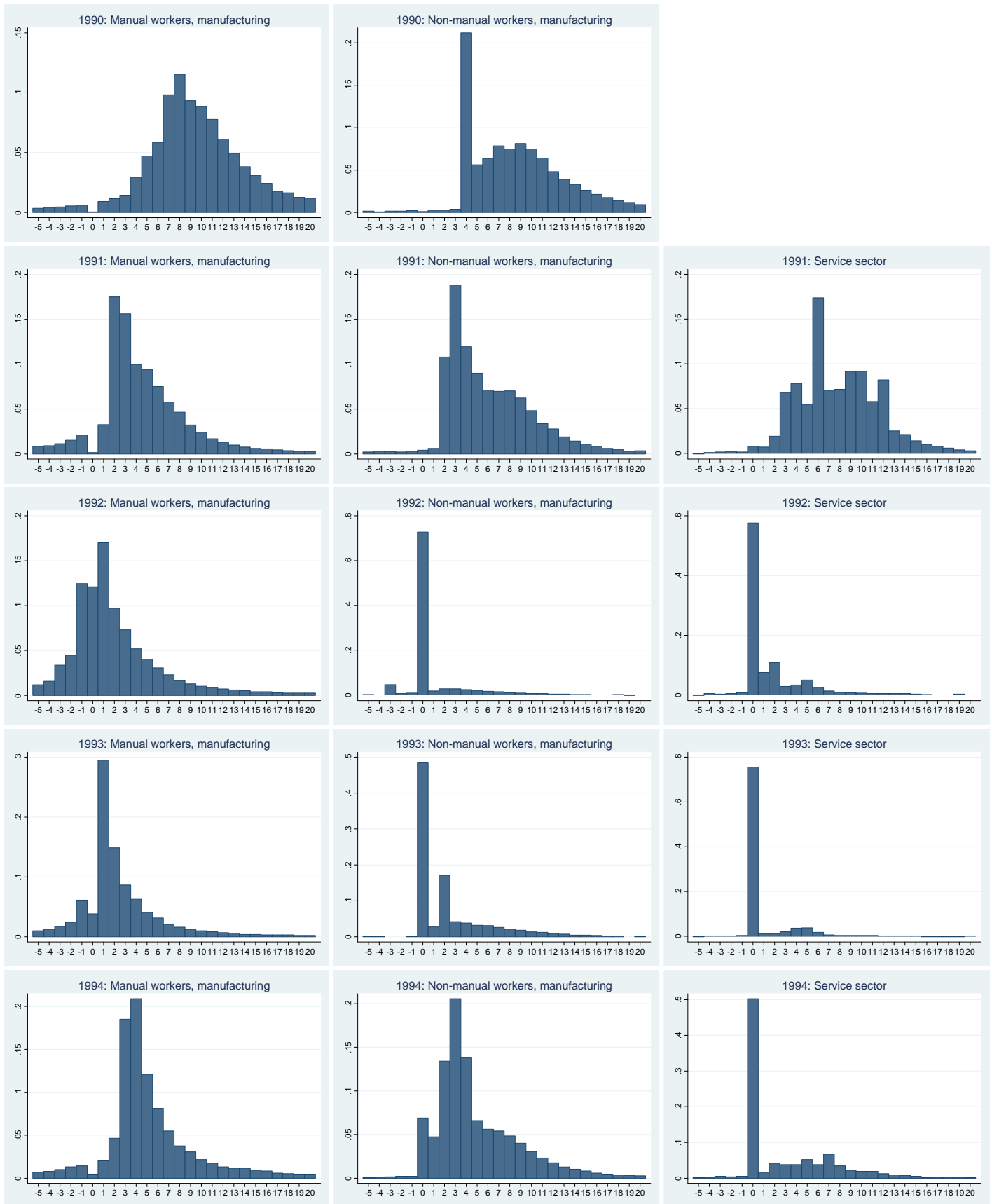


Panel D: Footwear



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. Macroeconomic aggregates: Simulated response to oil and trade shocks. Baseline calibration.

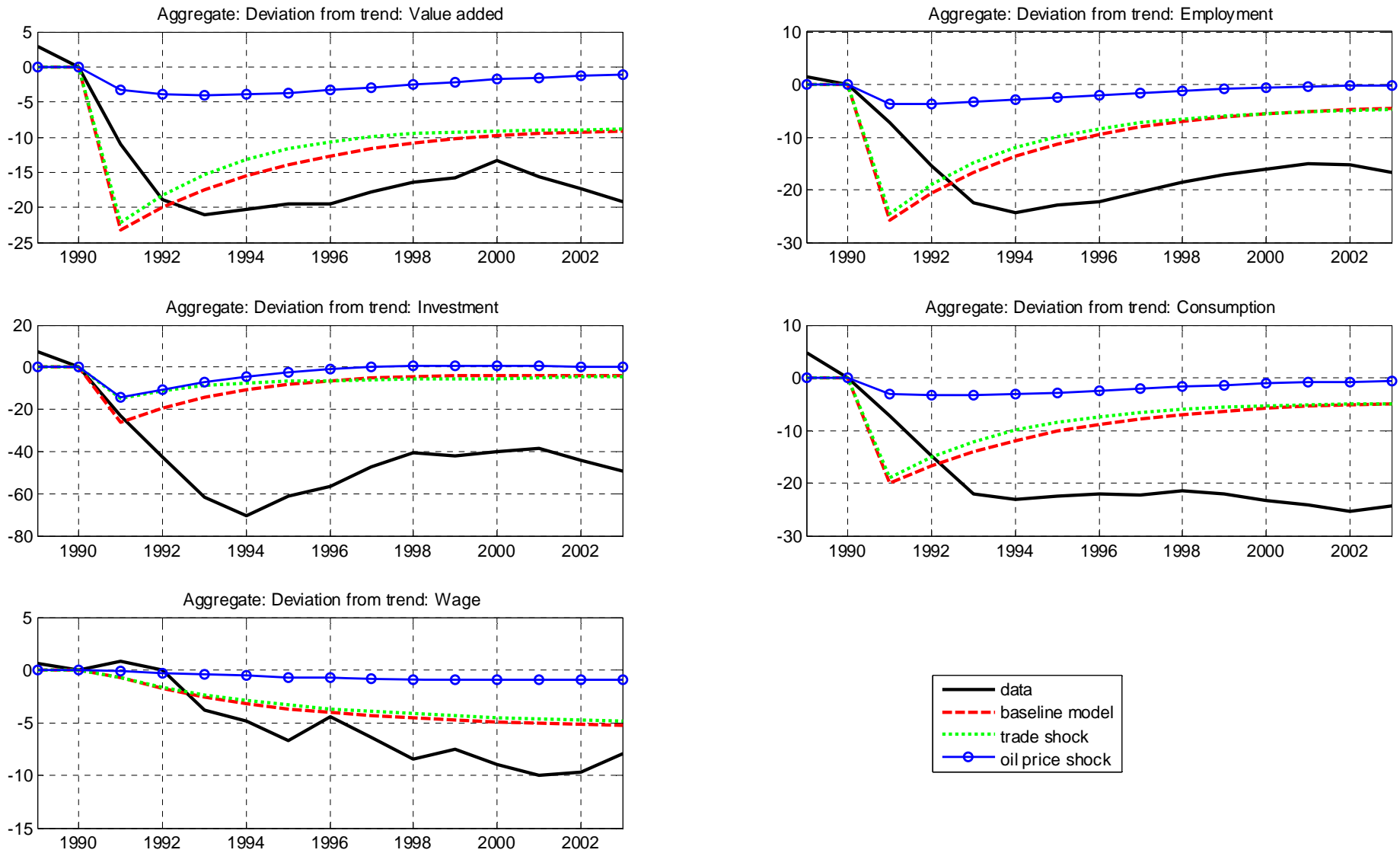
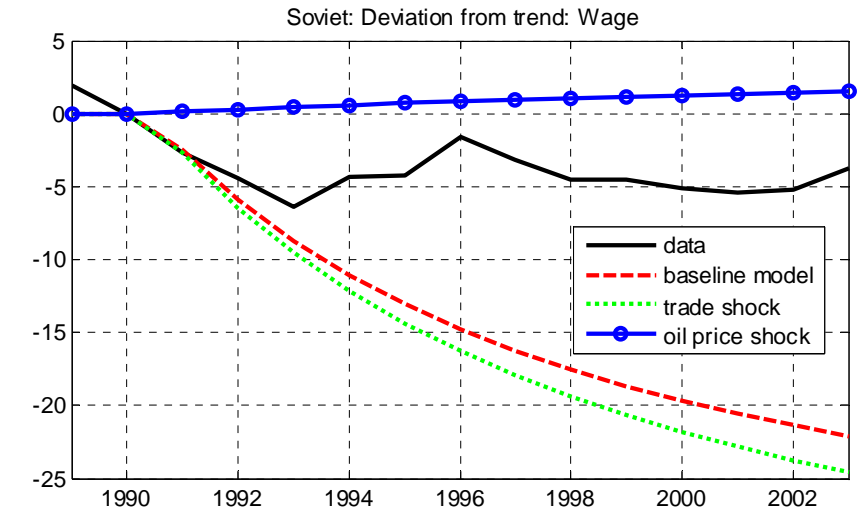
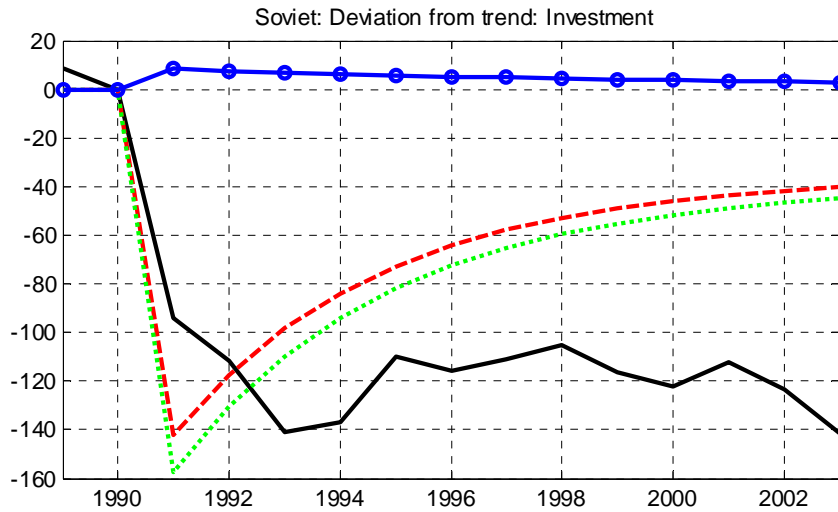
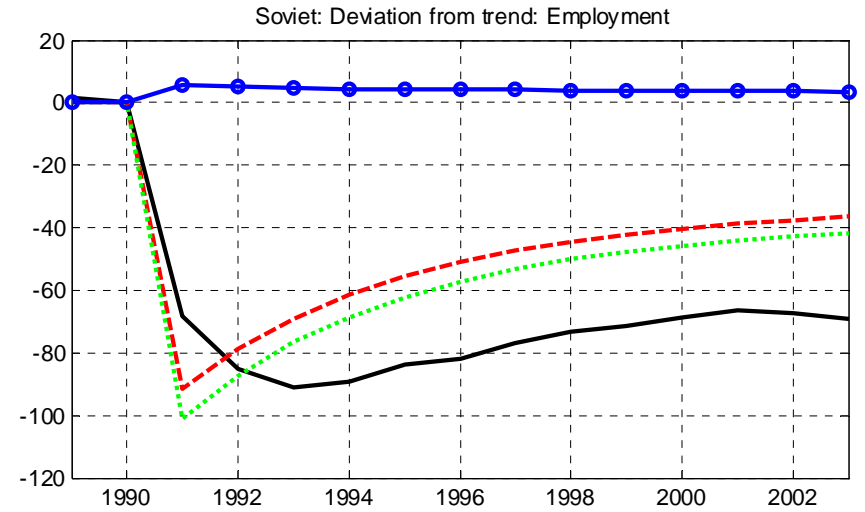
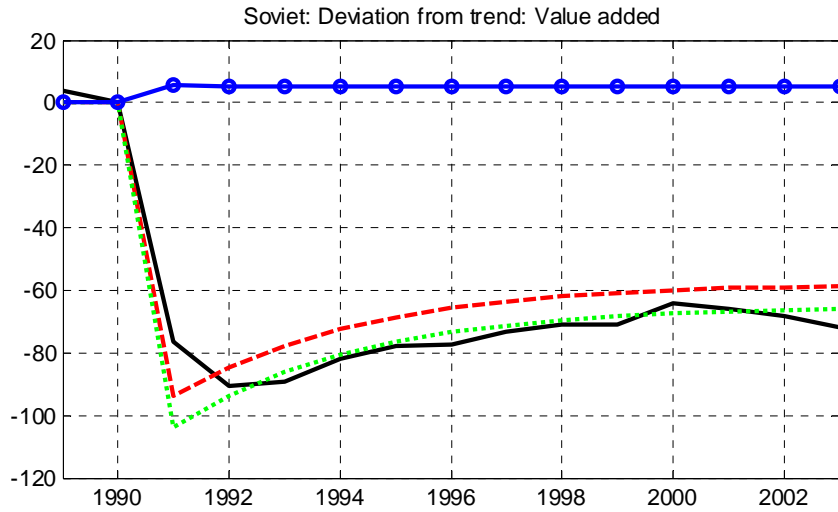


Figure 8. Soviet sector: Simulated response to oil and trade shocks. Baseline calibration.



— data
 - - - baseline model
 ... trade shock
 —○— oil price shock

Figure 9. Non-Soviet sector: Simulated response to oil and trade shocks. Baseline calibration.

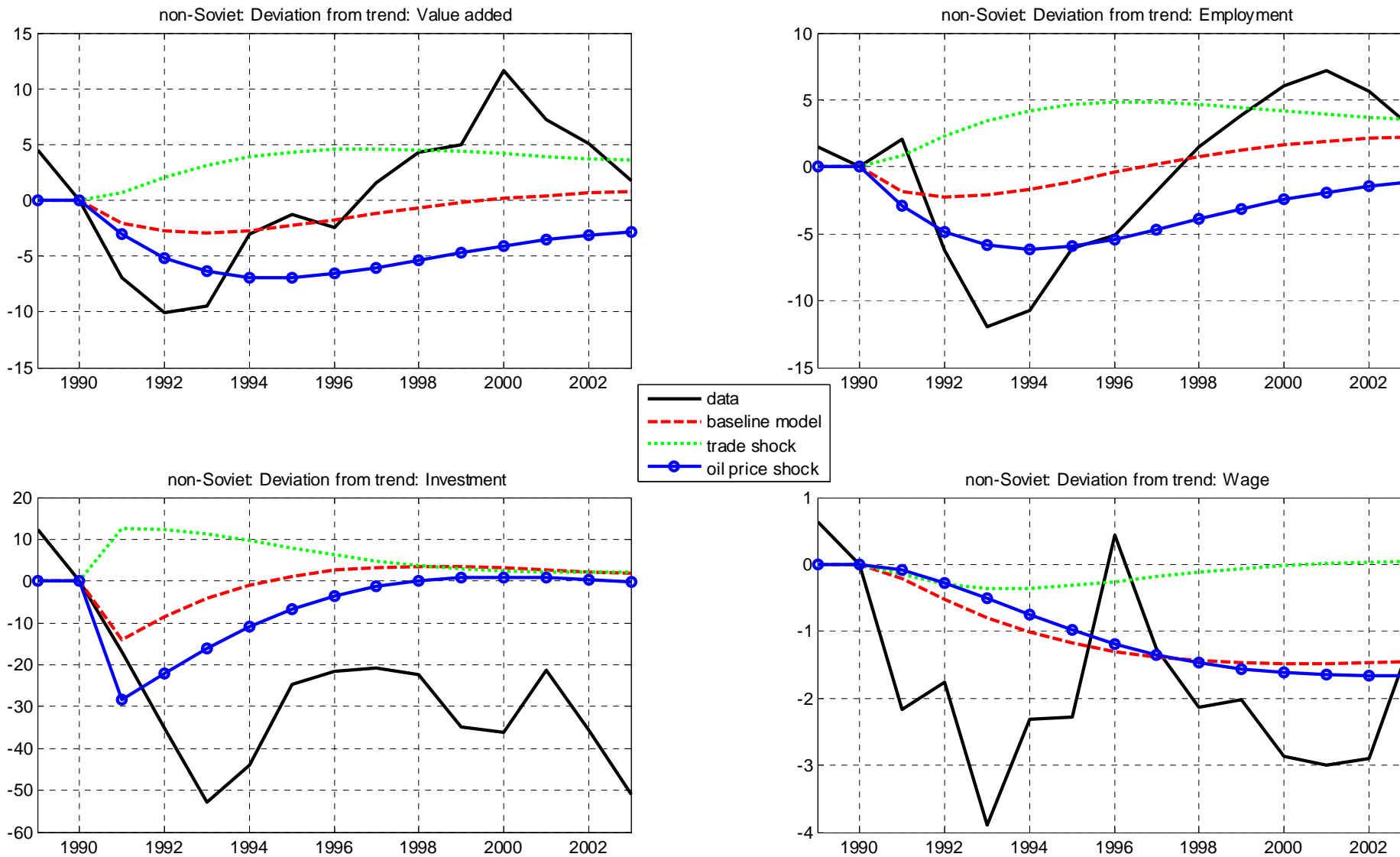


Figure 10. Service sector: Simulated response to oil and trade shocks. Baseline calibration.

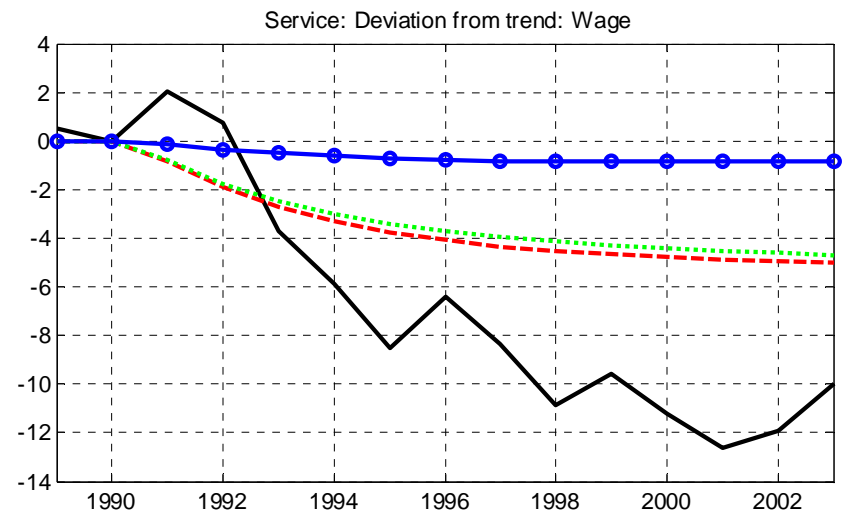
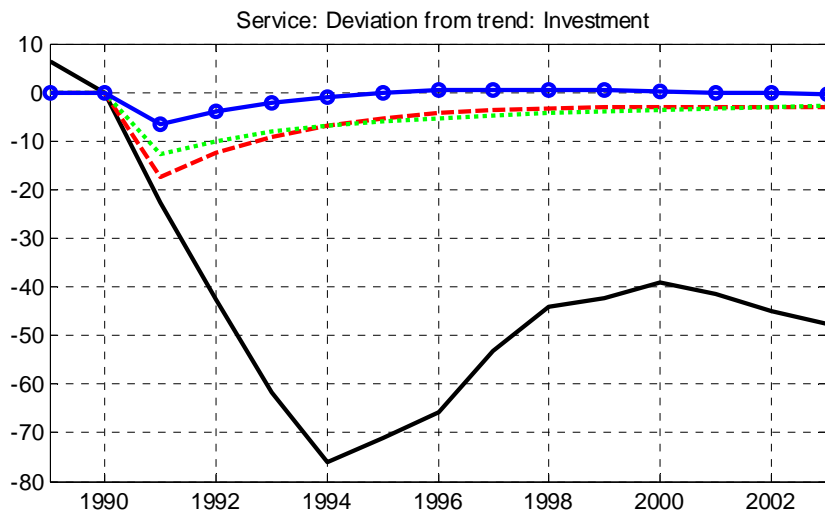
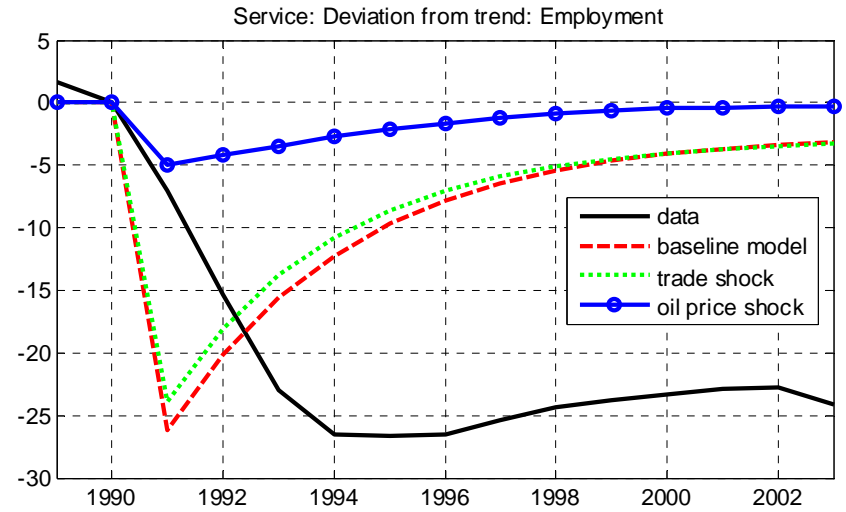
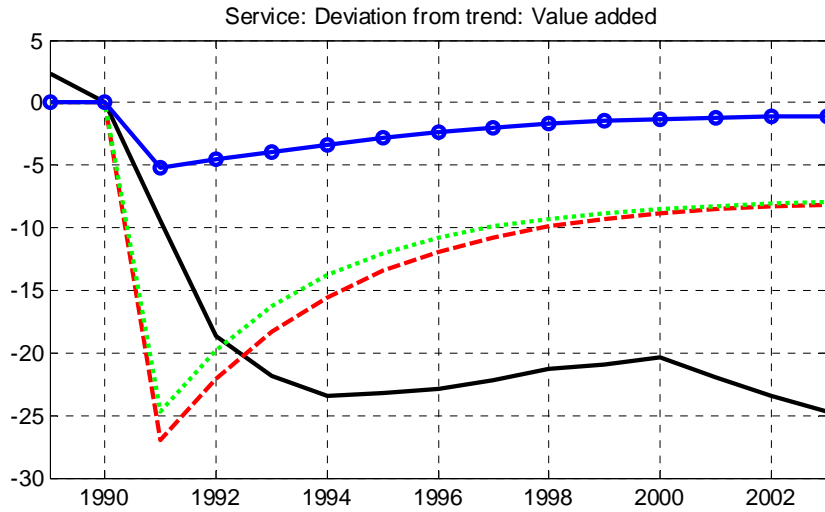
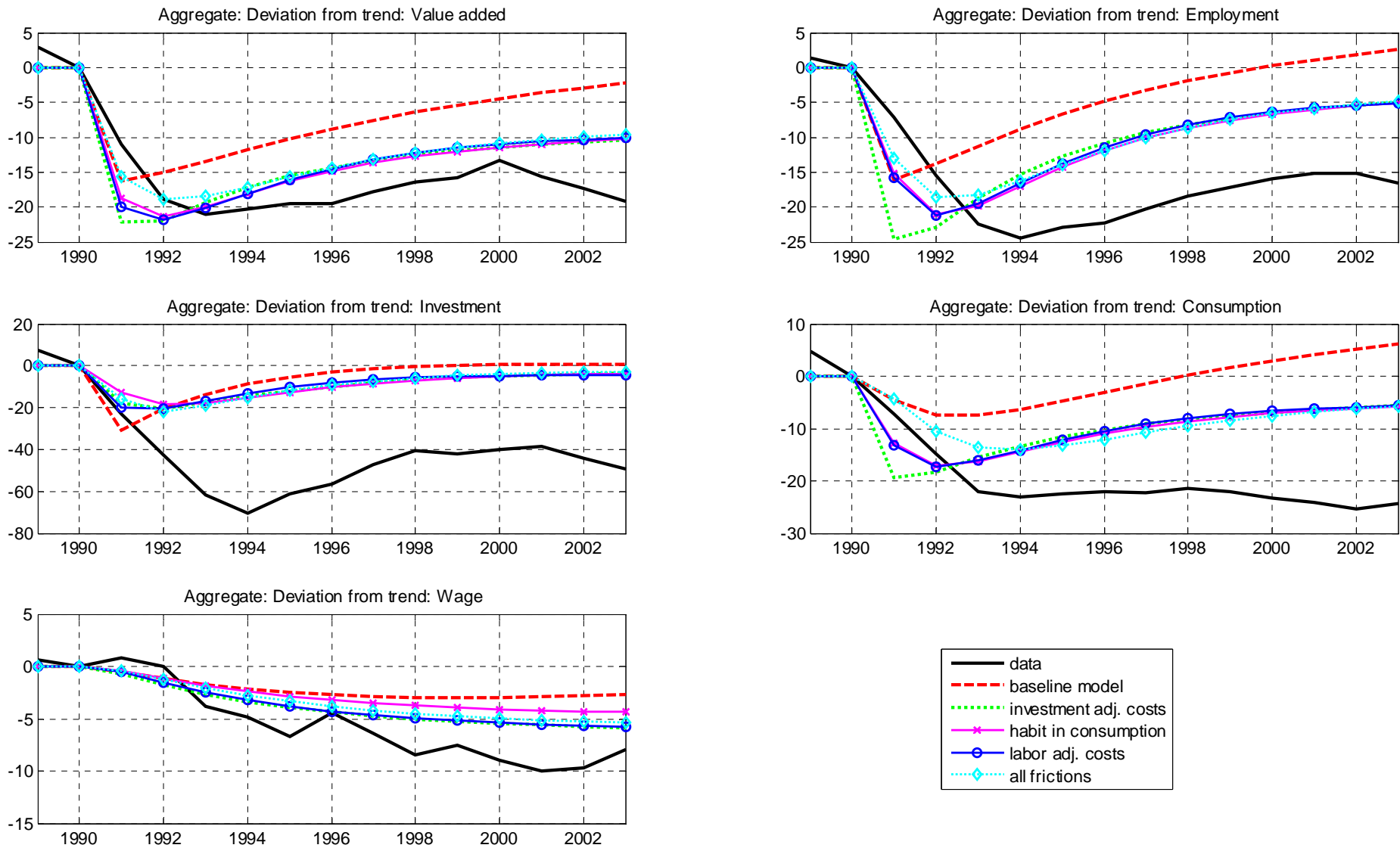


Figure 11. Macroeconomic aggregates: Effects of adjustment costs and habit formation.



Note: Scenario “all frictions” includes habit formation in consumption, investment adjustment costs, and labor adjustment costs.

Figure 12. Macroeconomic aggregates: Effects of production function parameters.

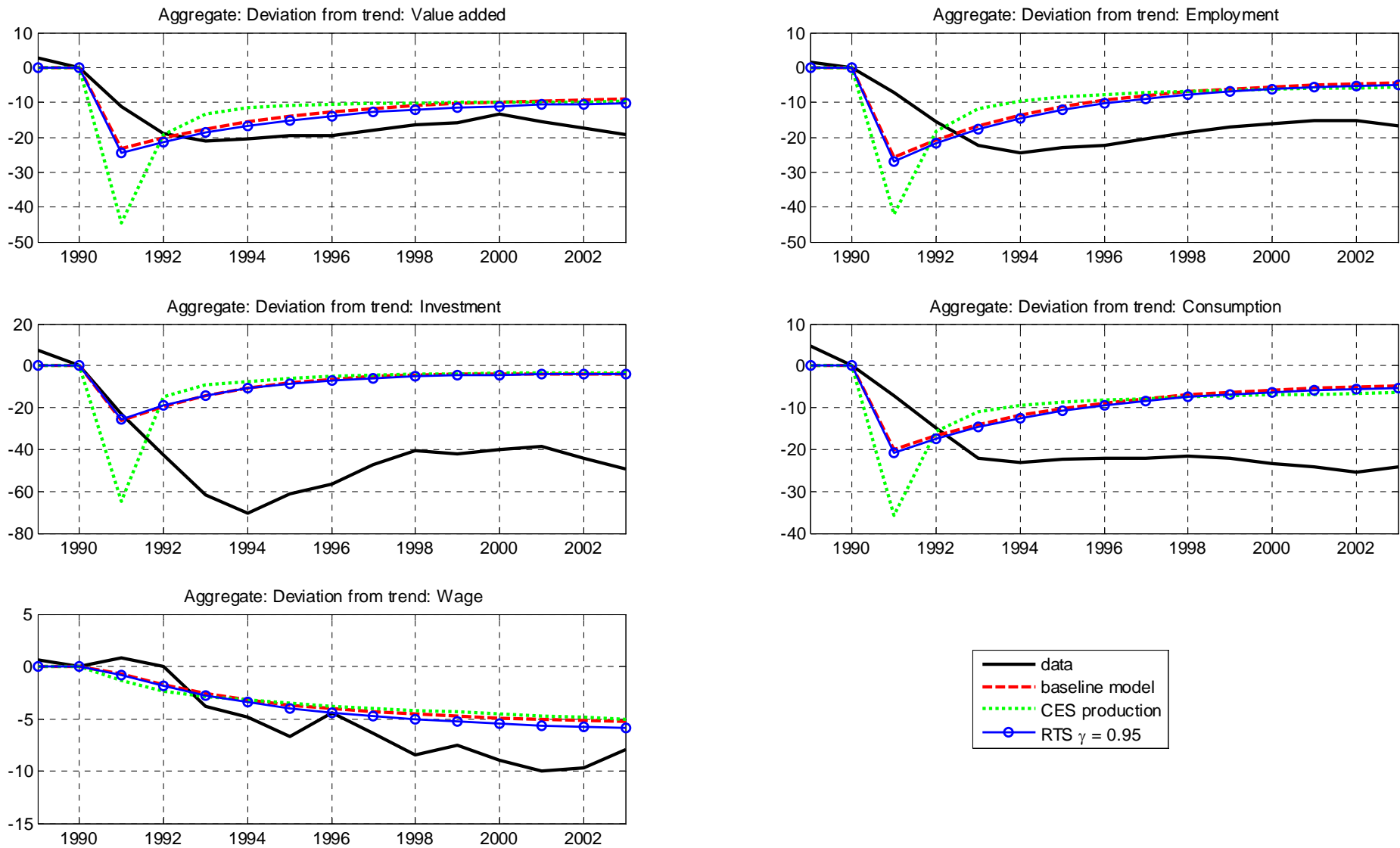


Figure 13. Macroeconomic aggregates: Effects of consumption parameters.

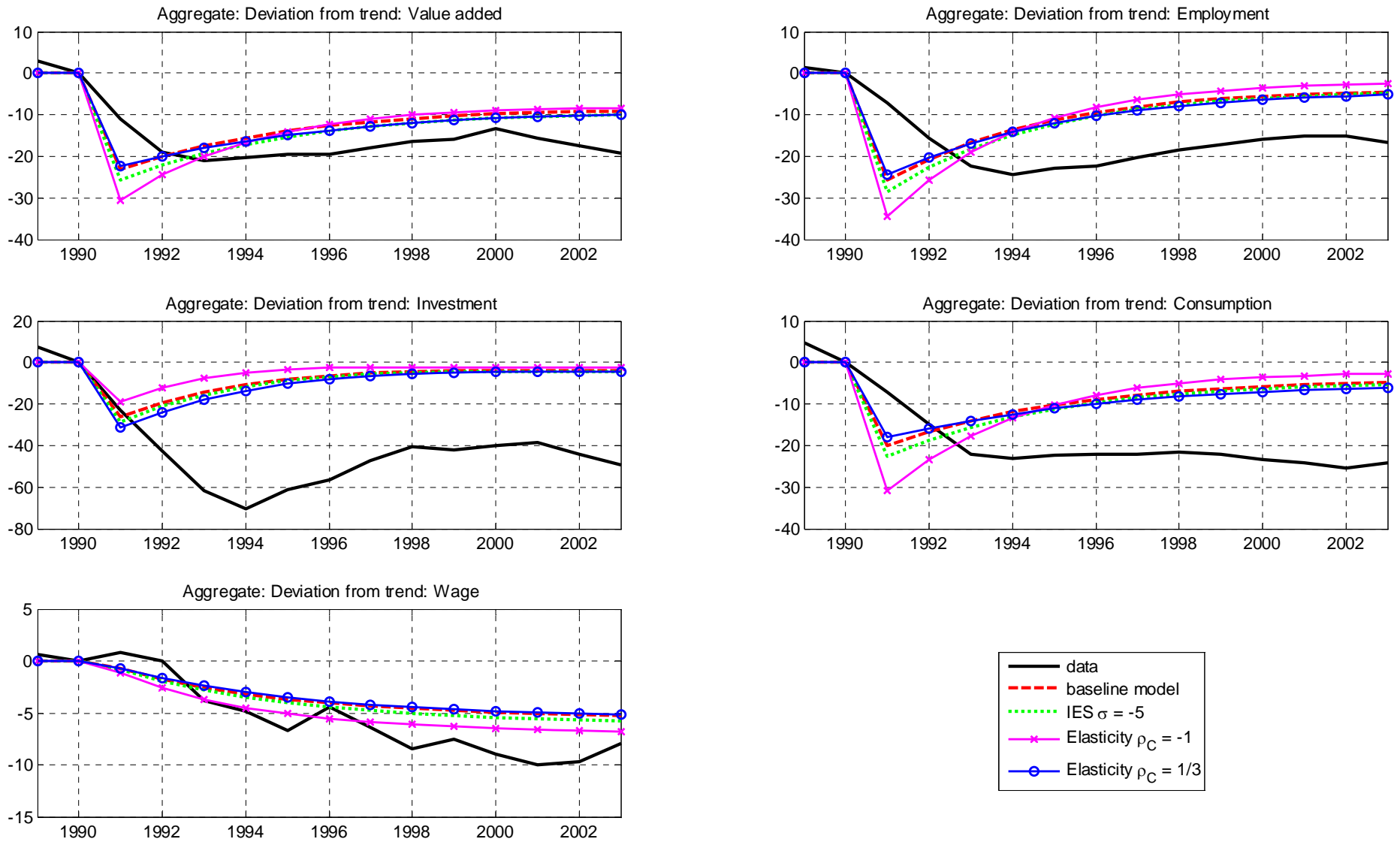


Figure 14. Macroeconomic aggregates: Effects of wage rigidity.

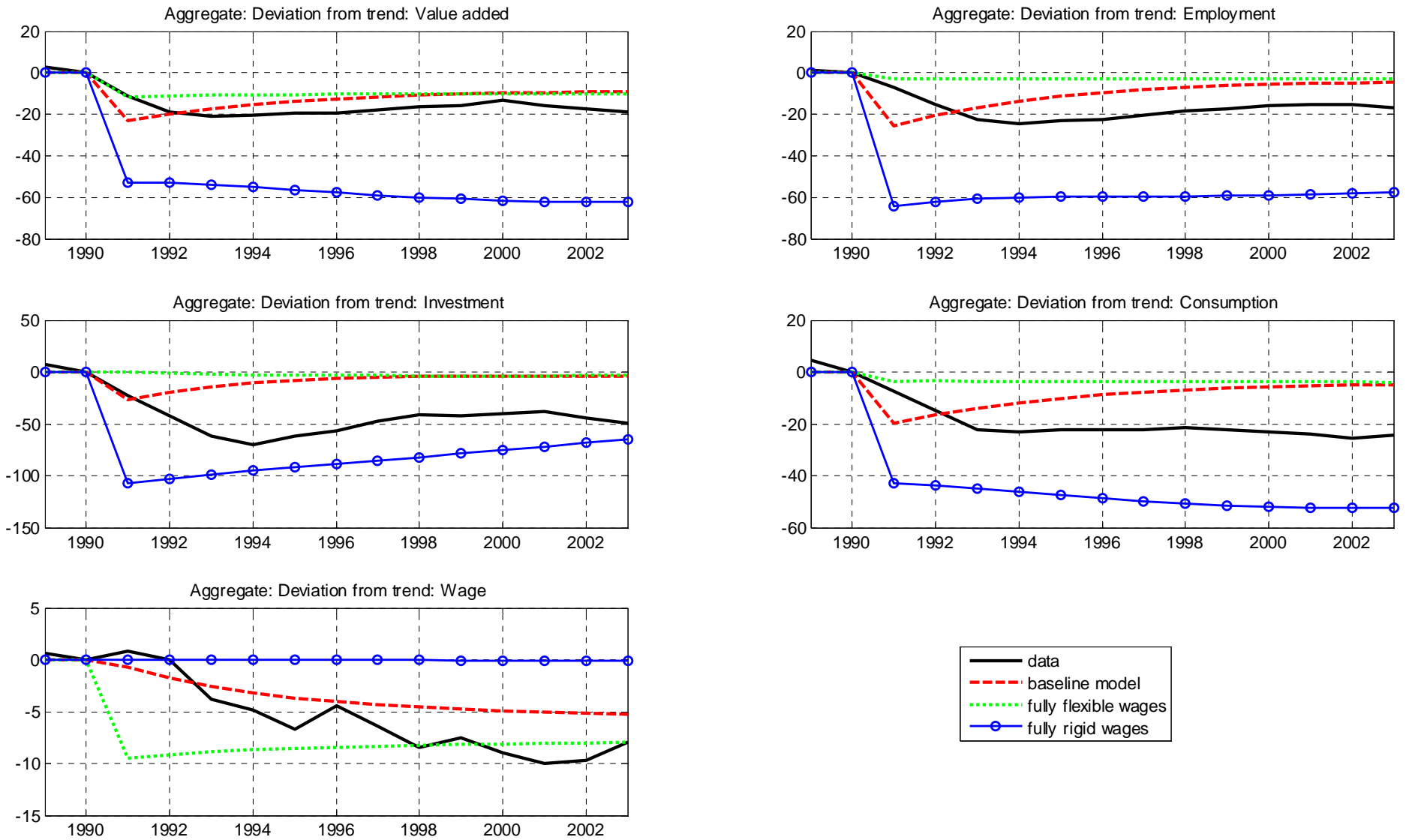
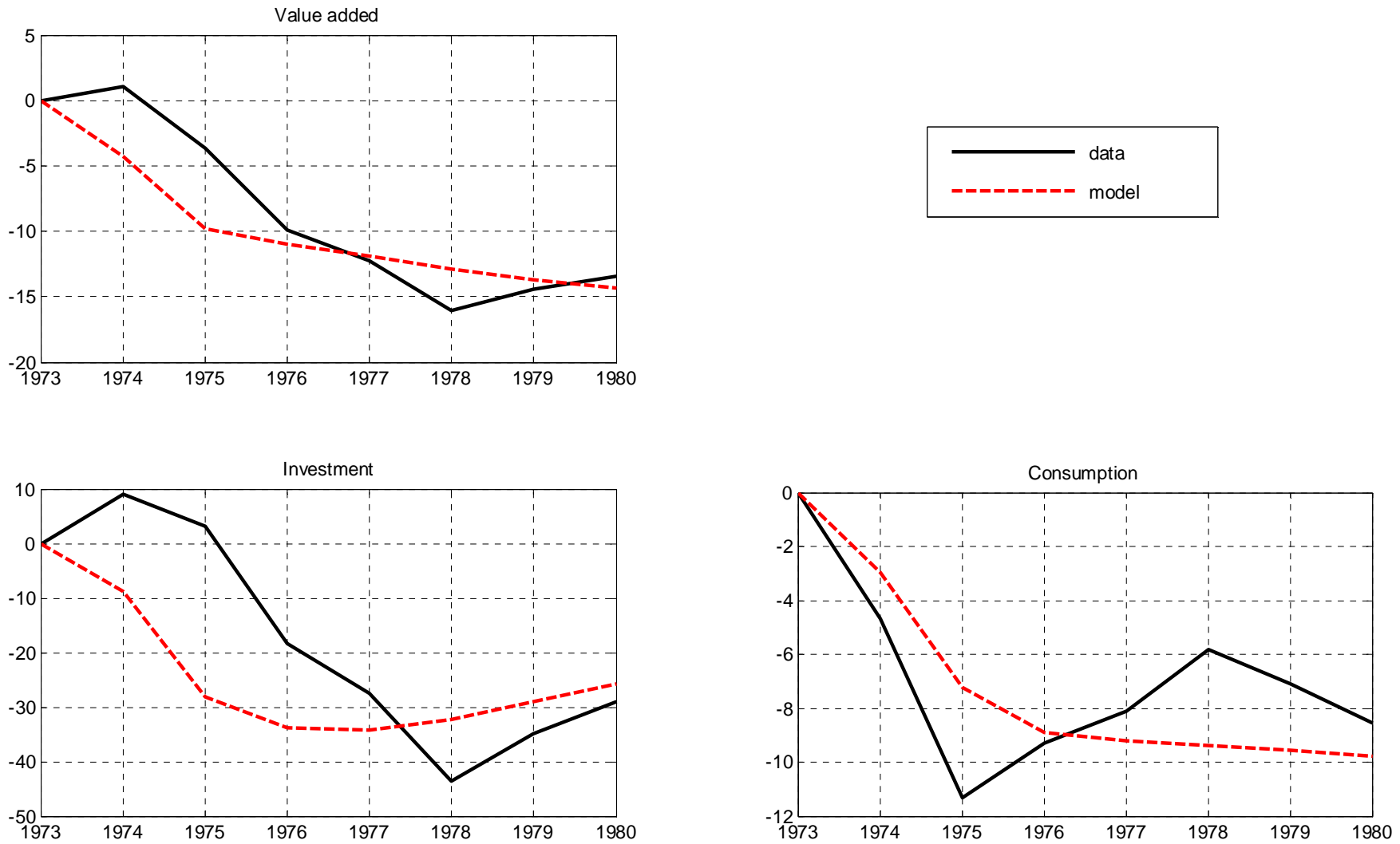
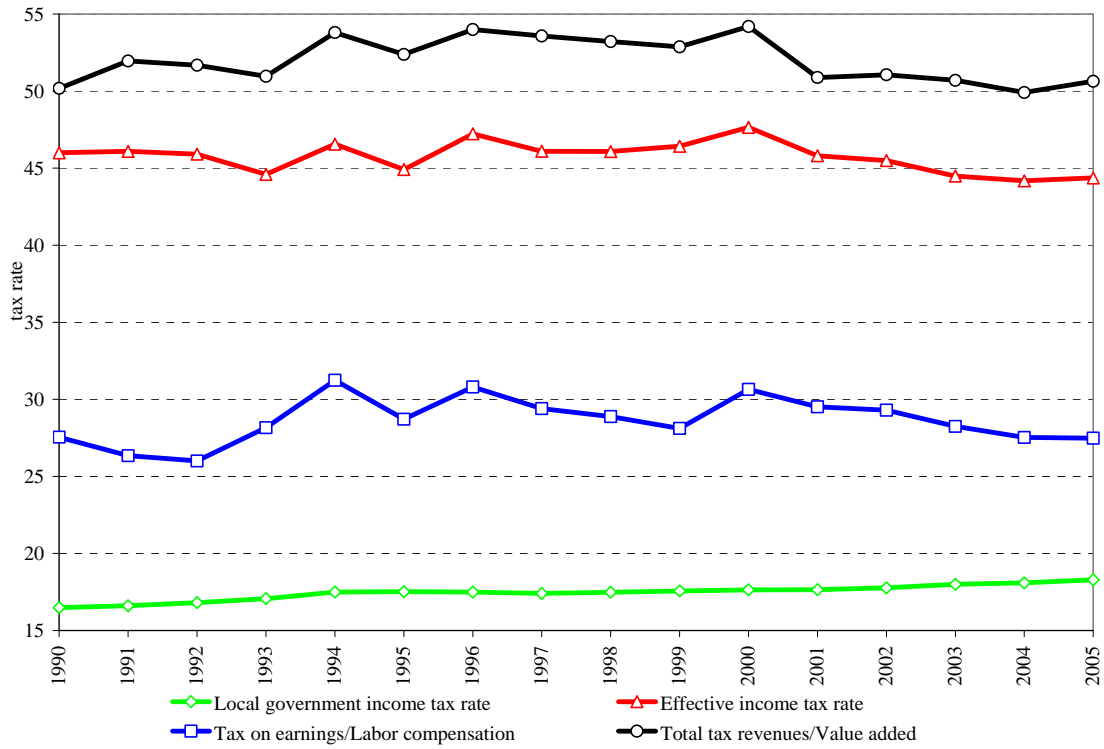


Figure 15. Oil price shock in 1974.



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 16. Tax burden.



Note: This figure reports the tax burden on income. Source: OECD, Finnish Ministry of Finance.

Figure 17. Macroeconomic aggregates: Interest rate shock.

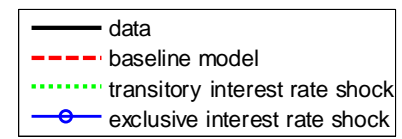
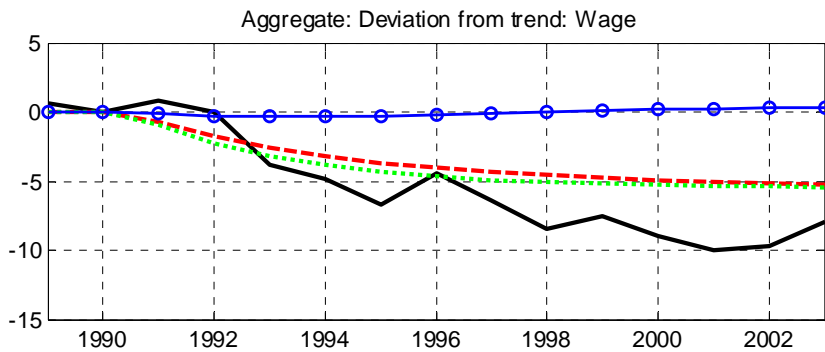
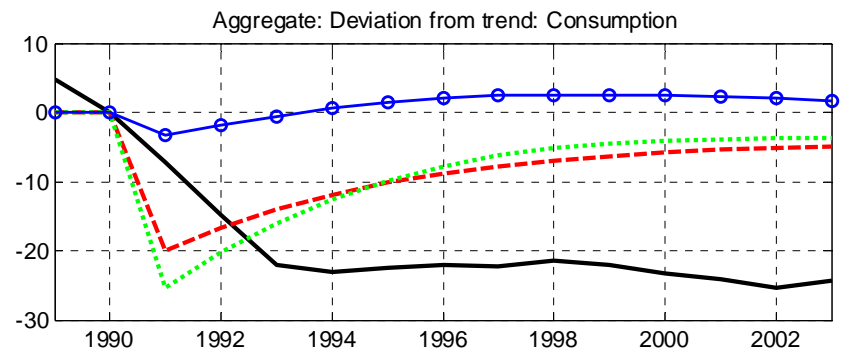
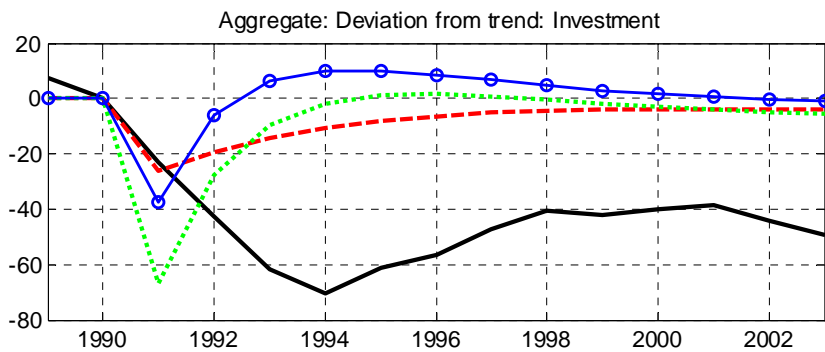
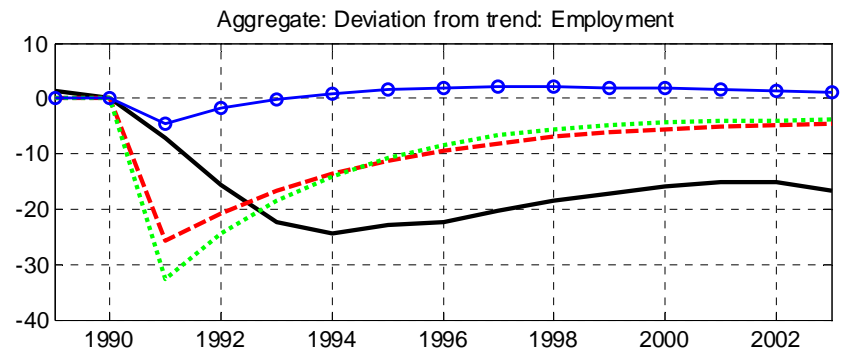
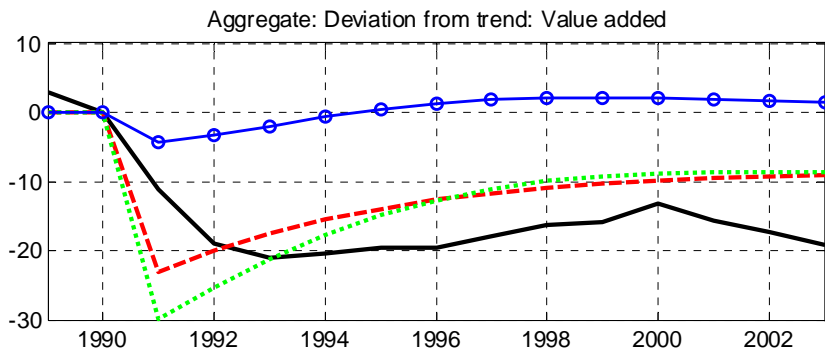
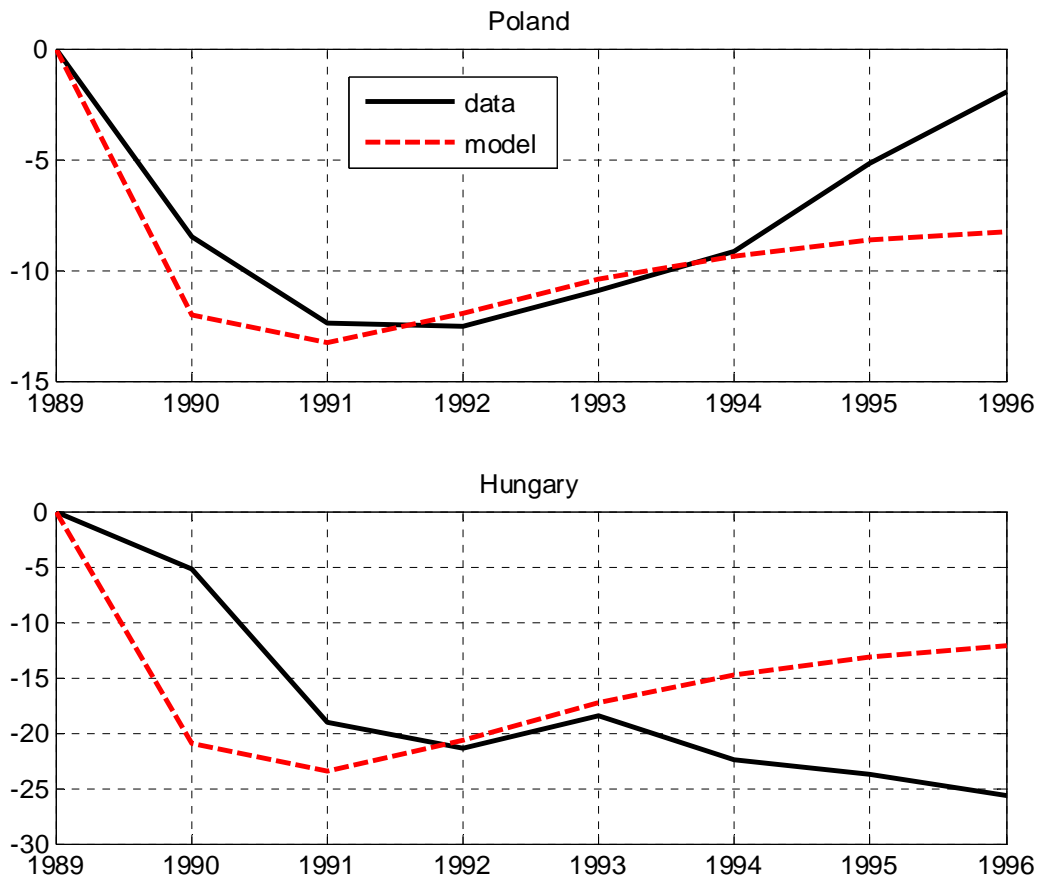
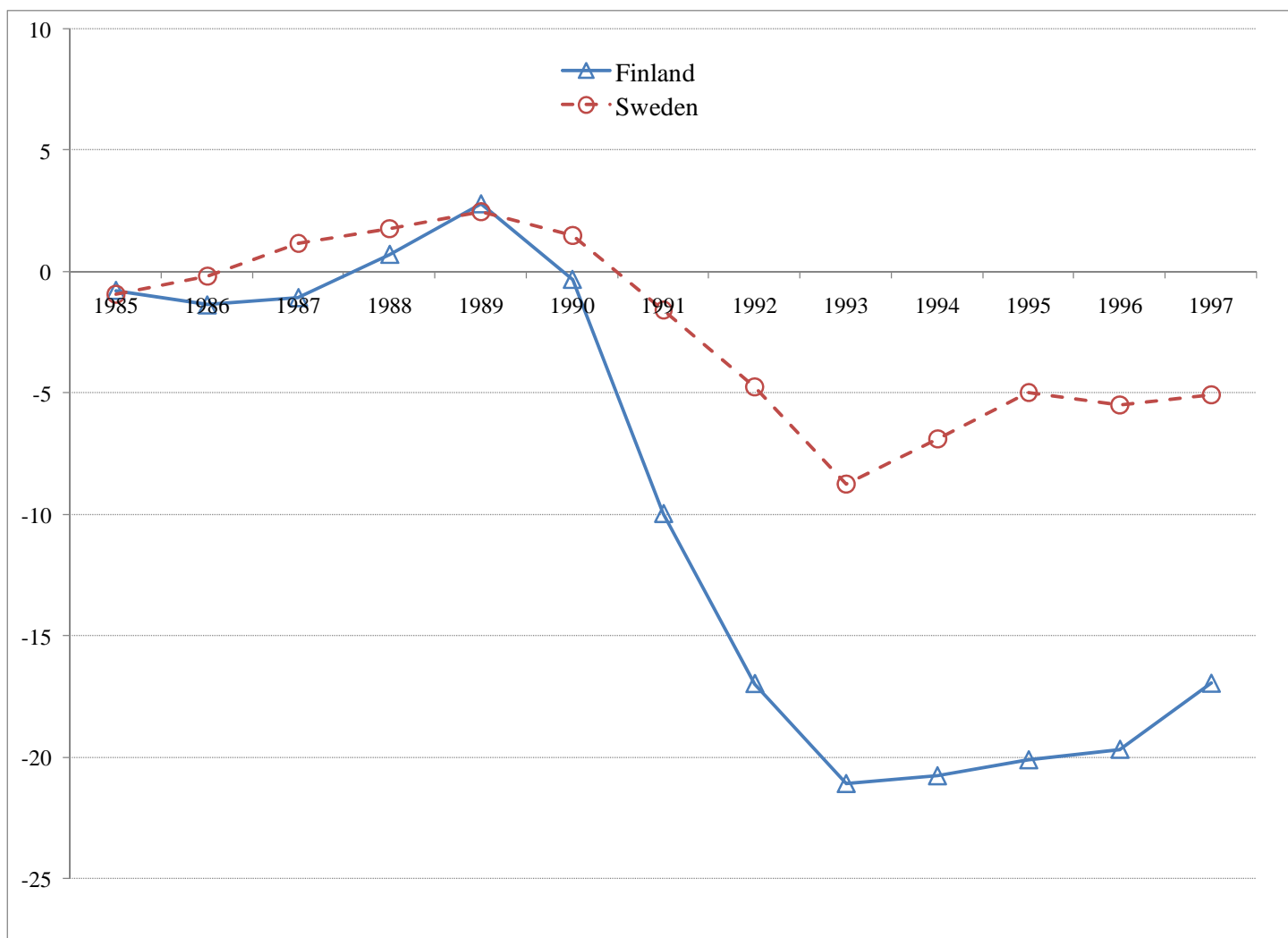


Figure 18. Output dynamics in Poland and Hungary.



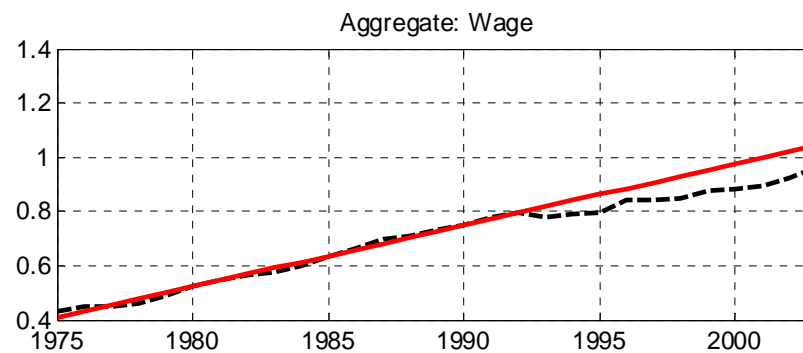
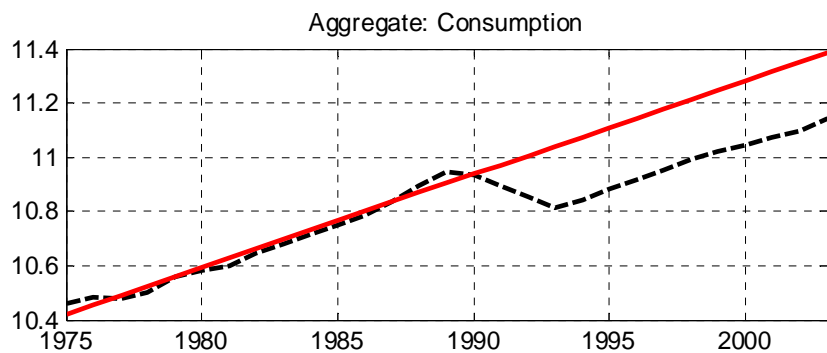
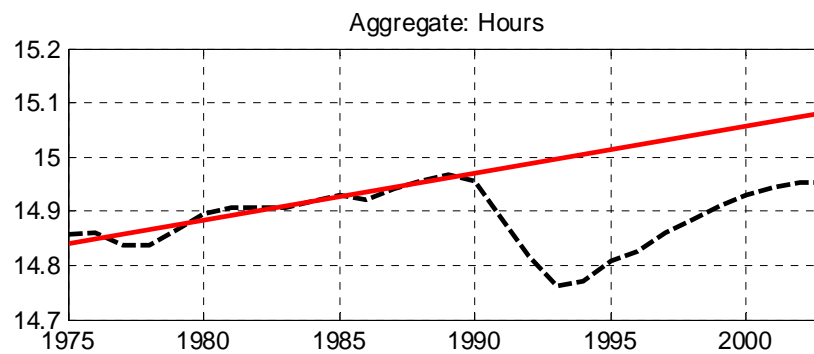
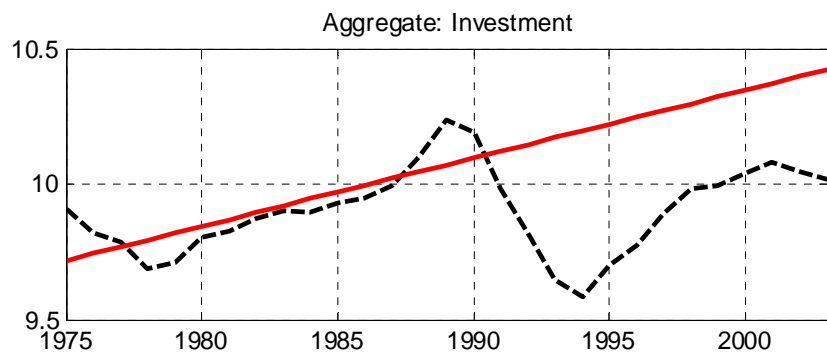
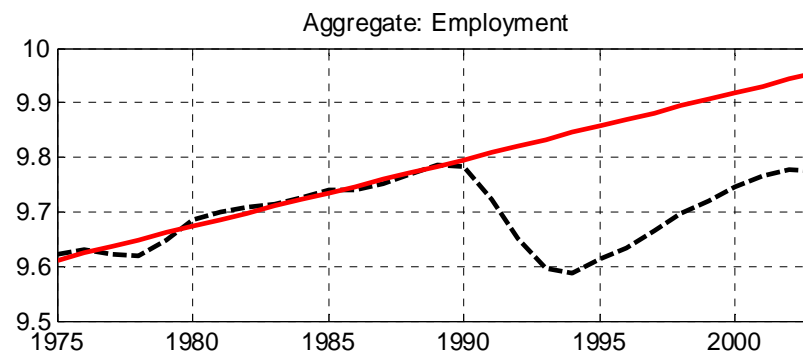
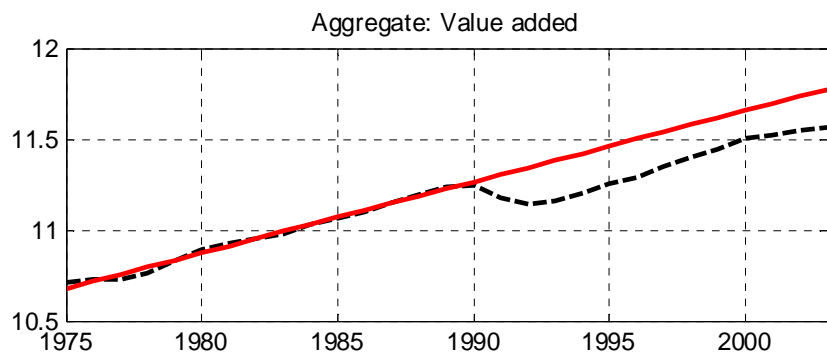
Note: Solid line is the deviation of real GDP series from the linear time trend estimated on 1970-1989 data. Real GDP (in 2000 prices) series for Hungary and Poland are taken from Penn World Tables. The deviation adjusted to be zero in 1989. Broken line is the model impulse response to collapse of the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

Figure 19. Output dynamics in Sweden and Finland, percent deviations from trend.



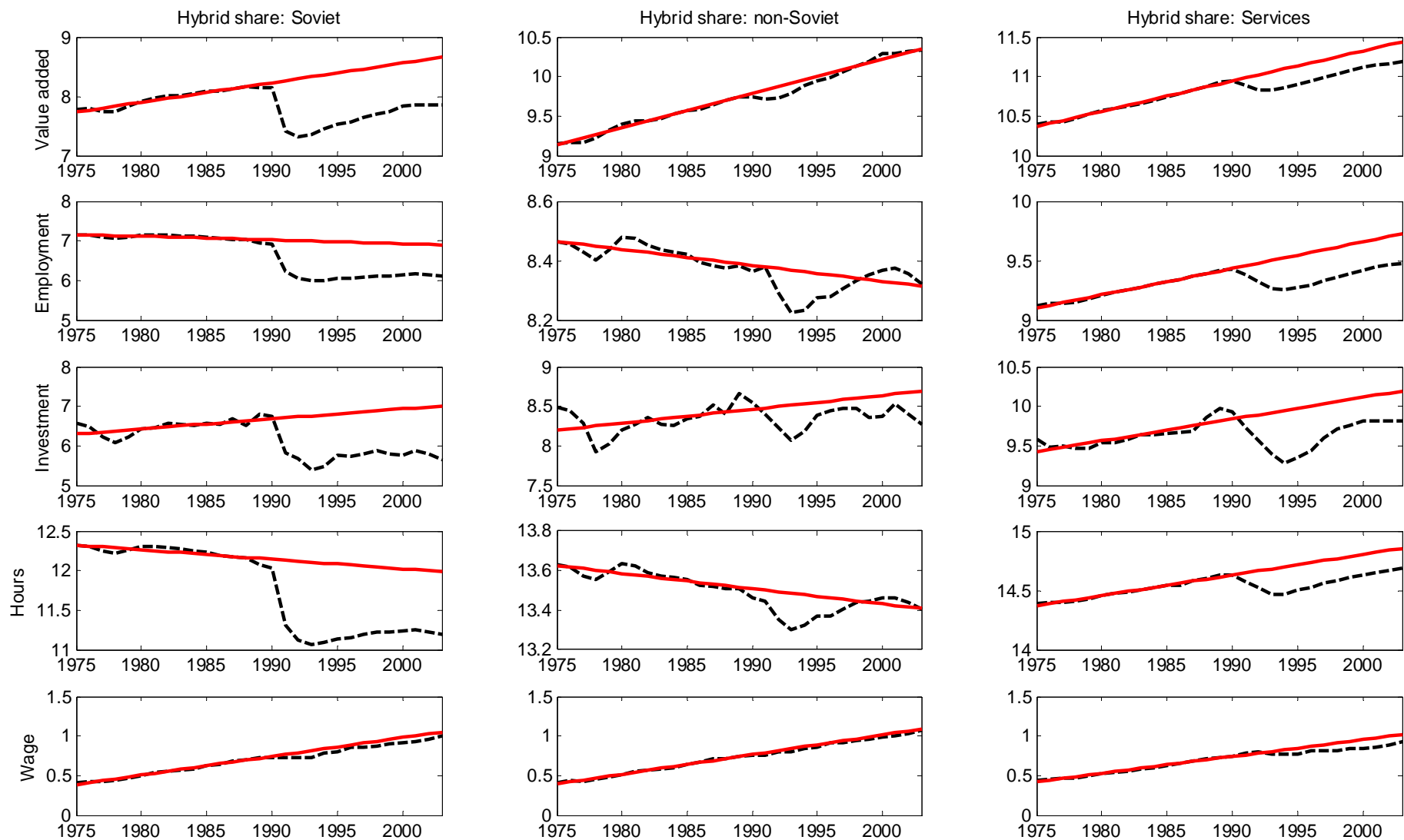
Note: the figure reports percent deviations from trend estimated on 1970-1990 sample of GDP (in logs) time series.

Appendix Figure 1. Macroeconomic aggregates: Actual series and estimated trend.



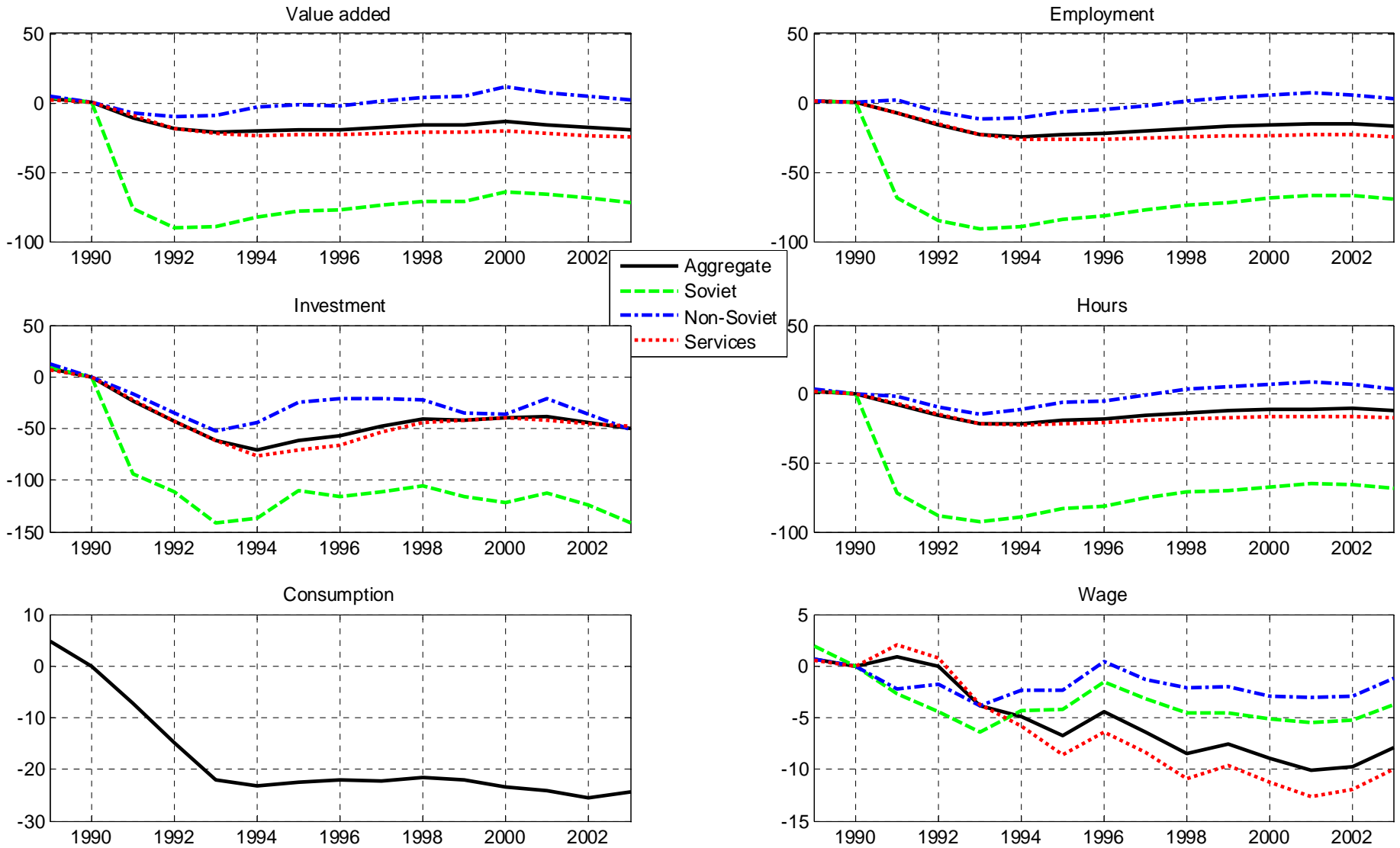
Note: The figure reports logs of real value added, real investment, real consumption, hours, and real wages. Solid line is time trend estimated on 1975-1989 data. Broken line is actual series.

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.

Appendix Figure 3. 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.

Appendix Table 1. Static cost of the collapse in Soviet trade.

| | 1989 | 1990 | 1991 |
|--|----------|-------------|---------|
| Panel A: | | | |
| A Imports from the USSR | 14,816 | 12,655 | 7,455 |
| F Exports to the USSR | 16,160 | 14,324 | 4,520 |
| 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 |
| M Market loss effect = $\mathbf{D} \times \mathbf{F}(-1) \times \mathbf{H}$ | | -661 | -3529 |
| N Terms of trade effect = $\mathbf{A} \times (\mathbf{C} - \mathbf{B})$ | | 1,522 | -1,376 |
| R Removal of subsidy effect = $\frac{1}{2} \times \mathbf{J} \times \mathbf{K} \times \mathbf{L}$ | | -5.8 | 0.8 |
| Total loss of income = $\mathbf{M} + \mathbf{N} + \mathbf{R}$ | | 856 | -4,905 |
| 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: | | | |
| Cumulative 1990-1991 total loss of income | % of GDP | Billion USD | |
| Poland | -3.5% | -2.20 | |
| Hungary | -7.8% | -1.97 | |
| Czech Republic | -7.5% | -3.40 | |

Note: The cost of the collapsed trade is computed 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.