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Yuriy Gorodnichenko
Enrique G. Mendoza
Linda L. Tesar

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Forschungsinstitut
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Institute for the Study
of Labor

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Yuriy Gorodnichenko
UC Berkeley, NBER and IZA

Enrique G. Mendoza
University of Maryland and NBER

Linda L. Tesar
University of Michigan and NBER

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IZA

P.O. Box 7240
53072 Bonn
Germany

Phone: +49-228-3894-0
Fax: +49-228-3894-180
E-mail: iza@iza.org

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ABSTRACT

The Finnish Great Depression: From Russia with Love*

During the period 1991-93, Finland experienced the deepest economic downturn in an industrialized country since the 1930s. We argue that the culprit behind this Great Depression was the collapse of Finnish trade with the Soviet Union, because it induced a costly restructuring of the manufacturing sector and a sudden, large increase in the cost of energy. We develop and calibrate a multi-sector dynamic general equilibrium model with labor market frictions, and show that the collapse of Soviet-Finnish trade can explain key features of Finland's Great Depression. We also show that Finland's Great Depression mirrors the macroeconomic dynamics of the transition economies of Eastern Europe. These economies experienced a similar trade collapse. However, as a western democracy with developed capital markets and institutions, Finland faced none of the large institutional adjustments that other transition economies experienced. Thus, by studying the Finnish experience we isolate the adjustment costs due solely to the collapse of Soviet trade.

JEL Classification: E32, F41, P2

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

Corresponding author:

Yuriy Gorodnichenko
549 Evans Hall #3880
Department of Economics
University of California, Berkeley
Berkeley, CA 94720-3880
USA
E-mail: ygorodni@econ.berkeley.edu

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I Introduction

Understanding great depressions has long been one of the central challenges in macroeconomics. Their massive costs as well as disagreement over their causes and propagation vehicles are subject to continuous debate. We examine the Finnish Great Depression of the early 1990s to shed new light on important transmission mechanisms that can drive great depressions through disruption of international trade relationships. We also show that our analysis of the Finnish Great Depression can be very useful for understanding the macroeconomic implications of large structural shocks affecting trade arrangements and the terms of trade in other countries (particularly in the case of the transition economies of Eastern Europe in the aftermath of the collapse of the Soviet Union).

During the 1991-93 period, Finland experienced the deepest economic slump in an industrialized country since the 1930s and the deepest peace-time recorded recession in Finnish history. As illustrated in Panel A of Figure 1, between 1990 and 1993 real GDP declined by 11 percent, real consumption declined by 10 percent and investment fell to 55 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.

We argue that the collapse of trade with the Soviet Union played a major role in causing the 1990s Great Depression in Finland, since it caused a costly restructuring of the manufacturing sector and a sudden, significant increase in the cost of energy. The barter-type trade arrangements between the USSR and Finland skewed Finnish manufacturing production and investment toward particular industries, and effectively allowed Finland to export non-competitive products in exchange for energy imports at an overvalued exchange rate. The demise of the USSR provides an exceptionally unique natural experiment for which we know with precision the timing, nature and size of the exogenous shocks that hit the Finnish economy. Furthermore, unlike previous analyses of earlier depressions or downturns in developing economies, we have access to high quality economic data at different levels of aggregation and frequency.

We develop and calibrate a multi-sector dynamic general equilibrium model that accounts for the key features of the Finnish Great Depression as the economy's response to the two shocks caused by the collapse of trade with the Soviet Union (the sudden loss of the market for specialized exports to the USSR and the surge in the relative price of imported energy). The 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 follows from the rise in energy costs and the reallocation of resources induced by the sudden obsolescence of the sizable sector that produced specialized goods destined for export to the Soviet Union. Our simulations also suggest that downward wage rigidity observed in Finland played a key role in the amplification of the downturn produced by these shocks.

We validate the model by examining its ability to match the behavior of the Finnish economy in a previous episode of a sudden rise in energy costs, the oil price hike of the 1970s. The model does well at reproducing the dynamics of macroeconomic variables in this episode. In addition, we compare the experience of Finland in the aftermath of the collapse of the Soviet Union with that of Sweden. Sweden is widely regarded as sharing many of the same structural features that characterize Finland, and it went through a similar initial economic downturn in the early 1990s (including currency and banking crises). Sweden did not, however, trade extensively with the Soviet Union. Hence this comparison provides us with a natural experiment in which one country (Finland) was hit by the Soviet shock and the other (Sweden) was not. Our findings from this comparison support the model's quantitative predictions, because the downturn in Sweden was much milder and of shorter duration than in Finland.

The impact of the trade shocks on Finland is interesting in its own right, but it is especially compelling in light of the similar experiences of the Eastern European transition economies (TEs). Panel B in Figure 1 plots 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 TEs (Blanchard and Kremer 1997, Roland and Verdier 1999). With the exception of Poland, output declined between 1990 and 1993 in all TEs, 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 the figure is that the adjustment path for Finnish GDP in the post-1990 period is virtually identical to those observed in the TEs.[1] Finland experienced the full

[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 (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 E1, we use Rodrik's method to compute the static

force of the Soviet trade shock, but as a western democracy with developed capital markets and institutions, faced none of the institutional adjustments experienced in the TEs. Thus, by studying the Finnish experience we isolate the adjustment costs due solely to the collapse of trade from the other burdens of adjustment borne by TEs. To the best of our knowledge, these results provide the first quantitative assessment of the significance of the trade shocks for explaining the downturn in these economies. To the extent that these shocks, combined with standard macroeconomic reallocation costs and frictions, can account for the depressions in TEs, the role of other factors such as institutional transformations may be smaller than previously thought.

The crisis in Finland has been examined in other studies that offer explanations alternative to ours. One view is that the origins of the Finnish depression were largely financial, working through the banking sector and ultimately triggering a twin currency-banking crisis (Honkapohja and Koskela 1999, Honkapohja et al 1996). Another view argues that labor tax hikes and negative productivity shocks may have been the culprit (Conesa, Kehoe and Ruhl, 2007). While these factors are obviously worth considering as additional important elements of the Finnish crisis, this paper shows that the mechanism we propose is relevant on its own and can also rationalize some of the empirical observations that motivate these alternative views.

In the next section of the paper we describe the key features of Finland's trading relationship with the USSR that are central to our argument. In Section III, we develop the dynamic model of the Finnish economy. In Section IV the model is calibrated using Finnish data before the collapse of Soviet trade. Then we hit the model economy with the shocks caused by 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 observed in the data. 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 TEs, and discuss how our conclusion for Finland can be extended to other countries. We make concluding remarks in Section VII.

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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.

II Finnish-Soviet Trade

Finland and the USSR had a series of five-year, highly regulated trade agreements, similar to the agreements between the USSR and its East European allies. These agreements established the volume and composition of trade between the two countries, and by the late 1980s they had evolved into a barter of Finnish manufactures for Soviet crude oil. In principle, trade was to be balanced annually, though arrangements were periodically made to allow for temporary imbalances.[2] These trade imbalances were the subject of annual interim negotiations and were usually cleared on the Finnish side through supplemental exports above the agreed quotas or on the Soviet side by additional petroleum exports.

By 1975, the USSR was Finland's most important trading partner. Panel C in Figure 1 plots the share of Soviet exports in total exports over the 1970-2003 period. 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. 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 authorities to identify those with real authority on the Soviet end of the bargain. The trade regime fully collapsed and all contracts with the Soviet Union were cancelled on December 18, 1990.

Roughly 80 percent of Finnish imports from the USSR in the early 1980s were in the form of mineral fuels and crude materials (Panel D, Figure 1). More than 90 percent of imported oil and 100 percent of imported natural gas came from the USSR. Under the terms of the bilateral agreement, the value of crude oil exports to Finland was determined by the dollar price of crude oil on the world market and then converted to rubles using the official ruble/dollar exchange rate. From the Finnish perspective, the volume of bilateral trade was thus a function of Finnish oil import demand given the world price of oil. During the oil crises of the 1970s, the oil-for-manufactures structure of trade provided Finland with a buffer against the cyclical fluctuations 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.

[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.

On the export side, the five-year trade agreements established explicit quotas for the export of manufactures 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. Typically, trade associations conducted the negotiations, applied for export licenses from the Finnish government, and distributed the rights to export among their members. A key condition of the export license was an 80 percent domestic content restriction. The majority of exports to the USSR took the form of manufactured goods and machinery and transport equipment, which included the production of ships.

It was widely perceived that exporting to the USSR was a lucrative business for Finnish firms. Pre-commitment to the five-year contracts eliminated exchange rate and business cycle risk for firms. Surveys of managers and industry experts indicated that Soviet trade was a low risk, low cost, and long-term business. In a survey of the structural effects of Soviet trade on the Finnish economy, Kajaste (1992, p. 29) concludes that "[Soviet] exports seem to have been exceptionally profitable." More formally, Kajaste (1992) uses unit prices of Soviet and non-Soviet exports and estimates that the prices of exports to the Soviet Union were at least 9.5 percent higher than those for exports to western markets. We find an even larger 36 percent markup when we replicate Kajaste's analysis using more recent trade data at 5-digit-level of disaggregation for 1990. This markup suggests that if a Finnish industry redirected its Soviet trade to other countries, its goods would be competitive only if sold at a 10 to 36 percent discount.[3] Hence, the Finnish economy was subsidized by overvalued prices of Finnish manufactures bartered for Soviet oil so that the effective price of Soviet oil was at least 10 percent cheaper than its market price.

[3] There are several reasons why the USSR was willing to overpay for Finnish goods. First, neutral Finland was the key source of modern Western know-how for the Soviet Union. For example, Finland supplied products with sensitive technologies such as deep-sea submersible, nuclear icebreakers, telecommunications equipment (Nokia), etc. Other countries had much tighter export controls against the Soviet bloc, with particular focus on blocking the transfer of technology. Second, the Soviet Union used the Finnish-Soviet trade as a lab for testing various forms of capitalist and socialist cooperation. 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." Third, the Soviet subsidy was aimed at maintaining political status quo in Finland where left parties played an important role. 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).

Finnish exports to the USSR were typically specialized for the Soviet market and did not compete directly with products traded in western markets. To assess the degree of specialization of the goods 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. Conditional on exporting a good 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 Council of Mutual Economic Assistance (CMEA), 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.[4,5]

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 was 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 the Soviet market, no sector was fully isolated from the loss of Soviet trade.

[4] 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 maintain a relatively large trade with the West, but of much importance is the fact that we are able to sell to the Soviet market in the main such goods that would be very difficult to market into the West." Cited in Sutela (2005).

[5] 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 were likely to be multi-product.

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.[6]

The collapse was quick and deep. Imports of oil from the USSR fell from 8.2 million tons in 1989 to 1.3 million tons in 1992. Exports tumbled down by 84 percent over the same period. Figure 2 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 counties. After the collapse of trade with the USSR in December of 1990, entire industries had to be reorganized throughout the early 1990s. 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 to be shut down.[7]

To fully understand the reaction of the Finnish economy to the collapse of the Soviet trade, it is important to examine the Finnish labor market because of its very high degree of 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).

[6] For example, in July 1990 the Wall Street Journal reported that Finnish Premier Harri Holkeri was surprised by the announcement that the Soviet Union would end the bilateral agreement 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. The private sector was equally surprised by the collapse of the Soviet trade. For example, Nokia remained confident that sales to the Soviet Union would continue at their mid-1980 levels. In 1991 Nokia's sales to the USSR came in at just 2 million markka instead of 121 million markka as projected. More broadly, Jonung (2008) argues that professional forecasters failed to predict the timing and later the depth of the coming recessionas well as the collapse of the USSR

[7] 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.

Since most employers are organized in federations, the wage bargaining normally starts at the national level. If a federation or union rejects the nation-wide agreement, it can negotiate its own terms. Collective agreements stipulate the wages for different levels of job complexity, education, etc. in a given industry. Typically, agreements allow upward wage drift if firms perform well. Although the government does not have a formal role in the bargaining process, the government usually intermediates negotiations.[8] Not surprisingly, Finland is often classified as a country with highly centralized wage setting (e.g., Botero et al 2004).

Unions did not agree to cut nominal wages in 1992-1993, which were the peak years of the depression.[9] Instead, wages were frozen at the 1991 level. Figure 3 reports the distribution of wage changes over 1990-1994 for individual workers. There is a clear spike at zero percent change for most types of workers in 1992 and 1993.[10] 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 Finnish Great Depression. Our micro level evidence strongly 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.

III A Model of Trade-Induced Great Depressions

In this section we develop a model of the Finnish economy that captures the key features of the trading relationship between the Soviet Union and Finland as well as the Finnish labor market. These features include the volume of trade, the composition of trade (barter of manufactures for

[8] See Snellman (2005) for a more detailed description of the wage bargaining process in Finland.
[9] Table E2 provides a summary of wage agreements in the 1990s.
[10] 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).

oil), overvalued terms of trade, low elasticity of substitution between goods destined for the Soviet market and western markets, and rigid labor markets.

We model the Finnish economy as a small open economy with three sectors. Sector 1 (non-Soviet sector) produces a traded good consumed at home and sold abroad in western markets. Sector 2 (Soviet sector) produces a good that can be consumed at home or sold exclusively to the Soviet Union. Sector 3 (services) produces non-tradable goods. We use baseline functional forms and parameters that seem the most consistent with the Finnish data or that help us simplify the analysis.[11]

Households

The representative household chooses a lifetime plan for consumption and labor allocations 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 and L_{it} for i=1,2,3 is the labor supplied to each sector. The consumption aggregator is given by $G_t = \{\zeta_1 C_{1t}^{\rho_C} + \zeta_2 C_{2t}^{\rho_C} + \zeta_3 C_{3t}^{\rho_C} + \zeta_4 C_{4t}^{\rho_C}\}^{1/\rho_C}$ where $1/(1-\rho_C)$ is the elasticity of substitution in consumption, ζ_j are weights in the consumption aggregator, C_{1t} is the consumption of the good produced by sector 1, C_{2t} is the consumption of the good produced by the sector with Soviet exposure, C_{3t} is the consumption of services, and C_{4t} is the consumption of a good imported from the western markets.[12]

We follow Greenwood, Hercowitz and Huffman (1988) and assume a period utility function $U(G_t, L_{1t}, L_{2t}, L_{3t}) = \frac{1}{1-\sigma}\left(G_t - \frac{\chi_1}{\eta_1+1} L_{1t}^{\eta_1+1} - \frac{\chi_2}{\eta_2+1} L_{2t}^{\eta_2+1} - \frac{\chi_3}{\eta_3+1} L_{3t}^{\eta_3+1}\right)^{(1-\sigma)}$ where $1/\sigma$ 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. Note that labor is sector specific and hence wages are not generally equalized across sectors.[13] Total employment is defined as $L_t = L_{1t} + L_{2t} + L_{3t}$.

[11] We provide in Appendix D a detailed sensitivity analysis that shows that our results are robust to relaxing several assumptions of the baseline setup. In particular, we introduce habit persistence in consumption, vary elasticities of substitution of sectoral labor supplies, allow for adjustment costs in investment and labor, allow for less-than-unitary elasticity of substitution between capital and labor and introduce decreasing returns to scale.

[12] The fourth consumption good allows the model to capture the fact that the Soviet trade accounted only for a fraction of total trade.

[13] We had a modeling choice between having sector specific labor supply and having decreasing returns to scale in production. These two options ensure that the production possibility frontier is concave and hence the model economy does not fully specialize (see Baxter (1992) for more details on linearity/concavity of the production

We assume that households are exclusive owners of domestic firms. Households face the following budget constraint:

$$w_{1t}L_{1t} + w_{2t}L_{2t} + w_{3t}L_{3t} + (q_{1t} + d_{1t})K_{1,t-1} + (q_{2t} + d_{2t})K_{2,t-1} + (q_{3t} + d_{3t})K_{3,t-1} + R_t B_t =$$

$$B_{t+1} + q_{1t}K_{1,t} + q_{2t}K_{2,t} + q_{3t}K_{3,t} + C_{1t} + p_{2t}C_{2t} + p_{3t}C_{3t} + p_{4t}C_{4t}\,, \qquad (1)$$

where w_j is the wage rate in sector j = 1,2,3, B_t is a one-period bond traded on international markets at the gross world interest rate of R_t, q_j is the price of capital in sector j, d_j is the dividend on capital in sector j.

Production

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

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

where δ is the rate of depreciation of the capital stock, ϕ is a capital adjustment cost coefficient, and p_{jt} is the relative price of goods in sector j (we take good 1 as numeraire so p_{1t} = 1) and p_t^E is the relative price of energy.

Production functions are given by $Q_{jt} = \min\{a_{jE}E_{jt}, (\alpha_{jK}K_{j,t-1}^{\rho_P} + \alpha_{jL}L_{jt}^{\rho_P})^{\gamma_j/\rho_P}\}$, for j=1,2,3, where a_{jE} is the energy requirement in sector j, $1/(1-\rho_P)$ is the elasticity of substitution between capital and labor, α_{jK} and α_{jL} are weights in the capital-labor aggregator, and γ_j measures returns to scale in sector j. We assume that energy and value added are perfect complements because the ability of firms to substitute away from energy is very small in the short run. At an optimum, no input is wasted so $a_{jE}E_{jt} = Q_{jt}$. Value added is defined 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

possibility frontier for economies where inputs can be accumulated). It was common in Finland that different units of firms produced goods for different markets (i.e., Soviet, non-Soviet, non-tradable). In our analysis we study the effects of the Finnish-Soviet trade collapse using synthetic sectors (i.e., Soviet, non-Soviet, non-tradable) constructed from disaggregate industry level data. Hence, we prefer sector specific labor supply because constant returns to scale in production allows straightforward aggregation of firms producing different goods (i.e., Soviet, non-Soviet, non-tradable) into sectors.

$F_j(K_{j,t-1}, L_{jt}, p_{jt}, p_t^E) \equiv Y_{jt}$. Note that for simplicity the three sectors do not have direct linkages via input-output relationships.

Using first-order conditions, we can find the shadow price of capital and dividend:

$$q_{jt} = p_{jt}(1+\phi_j(\tfrac{I_{jt}}{K_{j,t-1}} - \delta)),$$
$$d_{jt} = MPK_{j,t+1} - \delta q_{j,t+1} + p_{j,t+1}\phi_j(\tfrac{I_{j,t+1}}{K_{jt}} - \delta)\tfrac{I_{j,t+1}}{K_{jt}},$$

where $MPK_{j,t+1} = \partial Y_{j,t+1} / \partial K_{jt}$ is the marginal product of capital.[14]

Market clearing and equilibrium

In Sector 1, output is consumed, invested in that same sector (since investment net of depreciation, I, is also sector specific) or exported:

$$Q_{1t} - C_{1t} - I_{1t} - X_{1t} = 0, \qquad (3)$$

where X_1 measures net exports of the non-Soviet good. These are exports of goods to western markets in exchange for energy imports, M^*, purchased at a world relative price p^*, and for imports of good C_4 purchased at world relative price p_{4t}. Hence, the non-Soviet balance of trade can be defined as follows:

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

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

$$Q_{2t} - C_{2t} - I_{2t} - X_{2t} = 0, \qquad (5)$$

where X_{2t} measures export to the USSR. To capture the clearing system in the Finnish-Soviet trade, we assume that trade with the Soviet Union is balanced at all times. Hence, the Soviet trade balance is:

$$p_{2t}X_{2t} - p_t^S M_t^S = 0, \qquad (6)$$

where p_t^S is the barter price of energy contracted with the Soviet union for a quantity M_t^S of energy imports. The values of p_t^S and M_t^S are fixed, since they were set by the five-year agreements between Finland and the USSR.

[14] In some specifications of the numerical simulations we allow for returns to scale to be less than one. Profits in those cases are rebated to the household.

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

$$M_t^* + M_t^S - (E_{1t} + E_{2t} + E_{3t}) = 0. \tag{7}$$

In sector 3, since goods are nontradable, domestic production equals domestic absorption:

$$Q_{3t} - C_{3t} - I_{3t} = 0, \tag{8}$$

We enable the model to capture the slow adjustment of wages by assuming that real wages in each sector j=1,2,3 evolve as follows:

$$w_{jt} = \theta_j w_{j,t-1} + (1-\theta_j) w_{jt}^D, \tag{9}$$

where the parameter θ governs the degree of wage stickiness and w^D is the reservation wage given by the household labor supply. One interpretation of these wage 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. Given the wage, market-clearing in the labor market is demand determined (i.e. by finding the labor allocation that satisfies the labor demand condition and the settled wage).

An equilibrium of this economy is defined as intertemporal sequences of allocations $\{L_{1t}, L_{2t}, L_{3t}, C_{1t}, C_{2t}, C_{3t}, C_{4t}, I_{1t}, I_{2t}, I_{3t}, Y_{1t}, Y_{2t}, Y_{3t}, E_{1t}, E_{2t}, E_{3t}, q_{1t}, q_{2t}, q_{3t}, Q_{1t}, Q_{2t}, Q_{3t}, M_t^*, X_{1t}, X_{2t}, B_t\}_{t=0}^{\infty}$ and prices $\{p_{2t}, p_{3t}, w_{1t}, w_{2t}, w_{3t}, q_{1t}, q_{2t}, q_{3t}\}_{t=0}^{\infty}\}$ that solve the household's problem and the problem of each representative firm, and that satisfy the market clearing conditions (3)-(9), for given initial conditions $\{K_{10}, K_{20}, K_{30}, w_{10}, w_{20}, w_{30}\}$ and intertemporal sequences of exogenous variables $\{p_t^E, M_t^S, p_{4t}, R_t\}_{t=0}^{\infty}$. In our quantitative analysis we focus on equilibria that start from initial conditions calibrated to match the Finnish economy at a stationary equilibrium just before the collapse of the Soviet Union, and with the sequence of exogenous variables set to reflect the sudden increase in the cost of energy and the collapse of the market for exports to the USSR. The precise specification of these initial conditions and shocks is described in the next Section.

IV Quantitative Analysis

Data

One of the challenges in mapping 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_{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-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 as well as detrending in the data Appendix B. 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.

Calibration

The model is calibrated at a quarterly frequency. The quarterly deprecation 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 $1/\sigma = 1/2$, 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 $\eta = 1$.

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 $\zeta_1 = 0.15; \zeta_2 = 0.04; \zeta_3 = 0.54; \zeta_4 = 0.27$.

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 $\alpha_{3L} = 0.63$.[15]

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). 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 21.56. For other sectors, we cannot make this calculation directly because it depends on prices determined at 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: $a_2 = 37.84$ and $a_3 = 47.51$. These parameter values imply that the share of Soviet exports in total exports is approximately 18 percent, which is consistent with the share observed in the data.

Using information on employment shares and relative wages, we can calculate ratios $\chi_2 / \chi_1 = 4.127$ and $\chi_3 / \chi_1 = 0.324$. Because utility is Cobb-Douglas and we need only total expenditures on the imported good C_4, we set $p_4 = 1$, without loss of generality. Since χ_1 regulates only the scale of the economy, we set without loss of generality $\chi_1 = 0.4$. 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

[15] Empirical studies, however, tend to find that the elasticity of substitution between capital and labor is smaller than one. Thus, in our sensitivity experiments we examined the case with $\rho_P = -1$, which implies 0.5 elasticity of substitution between capital and labor. Also, the Cobb-Douglas formulation imposes constant returns to scale, but evidence for the United States documented by Rotemberg and Woodford (1995) and Basu and Fernald (1997) suggests that returns to scale may be about 0.97. Given that Finland has more concentrated industries, the share of economic profits may be higher than this estimate, so in our sensitivity analysis we set returns to scale to 0.95.

adjustment costs in capital stock: $\phi_1 = \phi_2 = \phi_3 = 1$.[16] We provide more details about the calibration in Appendix C.

As we have discussed above, wages in Finland are downwardly rigid and wage adjustment in the early 1990s was very slow. Indeed, we do not observe large movements in real or nominal wages in Finland over the 1990s (see Figure 3). In light of these facts, we set $\theta_1 = \theta_2 = \theta_3 = 0.99$, which corresponds to the maximum annual decline of real wages equal to 4% and approximately matches the 1-2% decline of real wages during the depression. By setting this high value of wage rigidity we want to capture downward wage rigidity in this particular historical episode since we anticipate that wages in our model will have to fall in response to the trade shocks caused by the Soviet collapse. Table 3 summarizes calibrated parameters.

Simulating the Effects of the Soviet Trade Collapse: Benchmark results

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 event at $t = 0$ in a deterministic environment. As we explained, this event produced two shocks for Finland. 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 shock as a permanent drop in Soviet oil imports M_t^S to zero for all t. This also implied that export to the USSR X_{2t} vanished. Hence, the second shock was the end of the Soviet Union's provision of subsidized energy for Finland. Our discussion in Section II suggests that this subsidy was at least 10 percent of the world oil price. Thus we assume that the second shock was equivalent to an increase in the oil price from $p^E = 1$ to $p^E = 1.1$ also for all t. We hit our model economy with these shocks as of the initial date t=0 and compute the transitional dynamics leading to the new post-Soviet-collapse stationary equilibrium. We assume that the bond position B_t is zero at t=0.[17]

Figure 4 plots actual and simulated responses for key macroeconomic variables measured as percent deviations from the pre-collapse steady state.[18] The model can capture the dynamics

[16] Groth (2006) presents the range of estimates reported in the literature.

[17] Following Mendoza and Tesar (1998), we use shooting and log-linear approximation around the post-Soviet-collapse steady state to adjust transitional dynamics for steady state changes in the net foreign asset position. We choose B_t=0 because the average net export to GDP ratio for Finland between 1980 and 1990 was very close to zero.

[18] Note that since we fit trends to each series in the data individually, we can have a discrepancy in the dynamics of output and inputs. Value added and consumption are computed in constant pre-collapse prices.

of output well in terms of magnitude. The model predicts an output decline of 20 percent nearly identical to that observed in the data, albeit the trough is reached in 1991 in the model versus 1992 in the data. Very similar results are also obtained for consumption and employment. Both decline about as much as in the data (about 24 percent), but both reach their troughs a year earlier than in the data. The model also approximates well the observed dynamics of wages. In contrast with the data, the model predicts a recovery in consumption while in the data it does not seem to recover. Note, however, that the model is in line with the data in predicting a protracted decline in consumption, although of about half the size (10 percent in the model v. 20-22 percent in the data). The model also predicts a moderate recovery in employment that is somewhat stronger than what is observed in the data. Consistent with the data, the model predicts an increase in the net export-GDP ratio, but the increase is gradual in the data while in the model it peaks in 1991.

The model predicts a 26 percent decline in investment over 1991-1993 and a recovery to about 12 percent below the long-run trend. This recovery reflects the fact that given our functional assumptions and calibrated parameter values, the capital stock to output ratio (and hence investment to output ratio) is fairly insensitive to changes in the price of energy, the relative prices and wages and consequently the new steady state level of aggregate investment is not much affected by the Soviet shock.[19] In contrast, investment in the data falls by 65 percent below the trend and although it slightly recovers by 1997 it stays 40 percent below the 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 5 shows the model and data responses for value added, investment, employment and wages at the sectoral level. Generally, the model captures well the qualitative features of the dynamics in the Soviet and service sectors, but quantitatively there are non-trivial differences. The model predicts permanent declines in value added, employment, investment and wages in the Soviet sector, but the model underestimates the drop in value added in the early years of the transition, and overestimates the declines in employment, investment and wages. In the services

[19] Specifically, in the steady state $K_j/Q_j = (\alpha_{jK}\beta(1-\frac{p^E}{a_j p_j}))/(1-\beta(1-\delta))$, which follows from the first order condition for capital in sector j. Note that since a_j is relatively large, one needs large variation in p^E and p_j to change capital to output ratio significantly.

sector, the model does well at matching the initial declines of all four macro aggregates, but it cannot match the highly persistent declines observed in the data. The model also understates the magnitudes of the declines in value added, employment, investment and wages in the non-Soviet sector.

In summary, the model performs reasonably well at matching aggregate dynamics, but is less successful at explaining some sectoral dynamics. It is particularly important to note the model's key prediction that the collapse of Soviet trade, which accounted for only about 5 percent of total employment and value added in Finland, can produce a significant contraction of output at the aggregate level (almost 20 percent in 1991).

The key to understand this strong amplification mechanism is in 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 have 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 that causes the relative price of oil to rise, increases 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 lead to a decline in the relative price of nontraded goods and 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 multiplicative effects on the initial shocks. Consistent with this argument, the relative prices of Soviet and non-tradable goods fell by 17.4 and 13.3 percent respectively below the trend between 1990 and 1995. The model predicts 18 and 5 percent decline after four years for prices of Soviet and non-tradable goods respectively. We return to quantitative assessments of the roles of nontradables and wage rigidity in the sensitivity analysis.

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 4). The economy's response to an oil price shock is much smaller than to the trade shock. 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 (Figure 5). This is consistent with the Finnish experience in late 1970s and early 1980s when oil prices increased. By contrast, the trade shock leads to an expansion in the non-Soviet sector. 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.

Sensitivity Analysis

In this subsection we vary parameter values to study the sensitivity of our results to alternative calibrations. First, we modify the model to introduce habit formation in preferences and add quadratic labor and investment adjustment costs (in addition to quadratic capital adjustment costs). Both habit formation and labor and investment adjustment costs make the responses of macroeconomic aggregates smoother, but neither adjustment costs nor habit formation are crucial for the qualitative results (see Appendix Figure D1). However, adding these features improves the model's ability to match the timing of troughs.

Next we study the implications of altering parameters of the production technology, the consumption aggregator and labor supply. Our qualitative results are not sensitive to changes in the production function parameters (Appendix Figure D2). Decreasing the elasticity of substitution between capital and labor from one to 0.5 amplifies the responses of all variables in the short run.[20] The quantitative results change little when we decrease returns to scale from 1 to 0.95. Likewise, we find that altering the elasticity of substitution in consumption across goods and over time does not change our main results much although the lower elasticity of substitution across goods tends to amplify the responses of macroeconomic aggregates (Appendix Figure D3). In addition, our results are not sensitive to varying the elasticity of substation of labor supply across sectors (Appendix Figure D5).

[20] In the richer model with habit formation and additional adjustment costs in the flow of investment and labor higher elasticity has smaller effects on the impulse responses.

Finally we study the implications of altering the degree of wage stickiness. In contrast with the other parts of the robustness analysis, we found that wage stickiness plays a very important role. In particular, the key parameter governing the response of the macroeconomic variables to the collapse of the Soviet-Finnish trade is the persistence of real wages (Figure 6). In the case with fully flexible wages, the recession is short and shallow. For example, output, employment, investment and consumption fall only by 2-5 percent and there are hardly any dynamics after the first year. 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 7.5 percent decline. At the sectoral level, 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 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 decreases in output, consumption, investment and labor. The recession is considerably deeper when wages are inflexible. In summary, our qualitative and, to a large extent, quantitative results depend only on adjustment of real wages being sufficiently slow and in this respect our findings echo the results in Cole and Ohanian (2004). As reported in Section II, however, there is strong evidence suggesting that this was indeed the case in Finland.

Figure 6 also shows the importance of the service sector in amplifying the response. Note that when we freeze the size of and prices for the service sector at the pre-collapse levels, we find that the size of the downturn at the aggregate level is only about half as large as the downturn when we allow the service sector to respond to the Soviet shock. This finding is in line with the intuition for amplification described above.

1974 Oil shock

Given the good performance of the model in explaining the recession in the 1990s, we are interested in assessing whether the model can also perform well in tracking the effects of previous episodes of energy price shocks. We examine in particular how the model fares in accounting for the macroeconomic dynamics after the 1974 oil price shock. Like the collapse of

Soviet trade, this shock produced a large increase in energy costs for Finland. Unlike the Soviet trade collapse, however, it did not cause a major dislocation in Finland's economic structure and sectoral factor allocations. In particular, during this episode Finland continued to import subsidized energy from the USSR in exchange for specialized exports. Hence, if in this 1974 oil shock experiment the model dynamics are still consistent with those observed in the data, we gain more confidence about the conclusions derived in the previous subsection. In this exercise, we keep the model calibrated as before. The only modifications we make are to the speed of wage adjustment, which we set to $\theta_1 = \theta_2 = \theta_3 = 0.9$ (Finland was less unionized in the early 1970s), and energy intensity, which we set a 25 percent higher (the Finnish economy was more energy intensive in 1970s than in early 1990s).[21]

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 7 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. Although we do not have reliable sectoral data before 1975 to construct counterfactual movements in the data in the absence of the shock, we know from 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.

Sweden vs. Finland

An alternative way to assess the importance of the collapse in the Soviet-Finnish trade in accounting for the Finnish recession as well as to validate our simulations is to compare the output dynamics in Sweden and Finland. Both countries had similar institutions (including regulated labor markets with high downward wage rigidity, see Botero et al (2004) and Dickens

[21] The ratio of energy consumption (in millions to TOE) to GDP (in constant 2000 prices) in 1973 was 25% larger than the same ratio in 1989.

et al (2007) for detailed comparisons) and experienced a similar and almost simultaneous sequence of events (including currency and financial crises) and policy responses in the late 1980s and early 1990s with the only major difference being that Sweden had miniscule trade with USSR.[22] In a sense, Sweden could be used as a counterfactual for what could have happened to Finland if it did not trade so much with the USSR. Hence, we can utilize this natural experiment to evaluate the predictions from our model.

Figure 8 plots the time series of percent deviations of output from linear time trend (estimated on 1970-1990 data) for Finland and Sweden. At the trough of the recession the output drop in Finland was about 22 percent from trend, while for Sweden it was 8 percent below trend. If we take the 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 fraction of the downturn in Finland.

V Alternative explanations of the depression

As we noted in the Introduction, two other competing explanations of the Finnish Great Depression are the “financial view,” which attributes the Depression to the major financial crisis experienced in Finland in 1992, and the “tax and productivity view” of Conesa et al. (2007), which argues that the Depression was caused by adverse TFP and labor tax shocks.

According to the financial view, 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. Clearly these factors played a role but they can also be interpreted as a byproduct of the financial-sector effects of the Soviet trade shocks that first caused a severe collapse of the real economy. Indeed, troubles in the Finnish financial sector seem to have followed the collapse of the Soviet trade rather than preceded it.[23] This interpretation of the

[22] Comparing the developments in Sweden and Finland between 1985 and 2000, Jonung, Kiander and Vartia (2009) observe that the two countries behaved as if they were “economic twins.”

[23] Real domestic credit, which had increased at a steady pace since the late 1970s, began to fall in 1992:1 and the exchange experienced a first initial depreciation in 1991:4, with a full currency collapse in 1993:1. Real GDP began

financial sector as "following" the real economy can be rationalized if we assume that financial variables responded to real developments as in a classic cash-in-advance setup. Hence, the severe retrenchment in consumption and investment expenditures due only to the Soviet trade collapse could have caused a proportional collapse in demand for real balances, which under a fixed or managed exchange rate and a set level of foreign reserves, could have been large enough to trigger a currency crash. If we consider also the possibility of financial amplification via a working-capital or financial accelerator channel, these developments could have fed back into the real economy and contribute to enlarge the magnitude and duration of the recession.

We can get a sense of the extent to which a credit crunch can explain the depression by introducing into our framework an exogenous, persistent increase in the world interest rate. We assume that the interest rate increased in 1991 by one percent (a relatively modest increase). 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. The corresponding impulse responses are shown in Appendix Figure D4. The results show that an increase in the interest rate depresses aggregate economic activity (with small effects on employment, output, and consumption but a larger effect on investment). We also find that adding the interest rate shock improves the fit of the 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. We conclude from these results that a credit crunch indeed can be a useful complement to our story, especially for matching the dynamics of investment.

With regard to the tax and productivity hypothesis of Conesa et al. (2007), it is worth noting that our oil price shock works like a technology shock since an increase in oil prices reduces firms' profit margins (provided there is a sufficiently small substitutability of energy input).[24] Although the effect of the oil price shock on measured TFP is relatively small in our model, the trade shock leads to a significant decline in measured TFP with the dynamics that resembles the path of measured TFP in the data (Appendix Figure E1). Thus what Conesa et al.

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contracting in the last quarter of 1990. In a comprehensive analysis of the banking crisis and credit crunch, Vihriälä (1997) concludes that collapse of lending is better explained by a decline in firm and household balance sheets and creditworthiness than by a contraction in supply of credit.

[24] A similar argument was made for the case of the United States by Finn (2000).

interpret as a TFP shock could be partly capturing the energy price and trade shocks in our model.

We can also reconcile Conesa et al.'s labor-tax-like effects with our analysis by interpreting those effects as taking the place of the wage rigidities in our model. In an equilibrium without labor 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, since firms stay on their labor demand curve, they cut employment. Because of these arguments, we can reconcile decreased employment (as observed in the data) with fully flexible wages (as assumed by Conesa et al. (2007)), if we 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 the after-tax wage is equal to the reservation wage.

While both labor tax hikes and wage rigidities can have similar theoretical effects, we were unable to find actual evidence of changes in tax rates in the Finnish press and legislation of the early 1990s. In addition, various measures of the tax burden on labor earnings exhibit little variation over this period (see Appendix Figure E1). By contrast, we documented earlier strong evidence of labor rigidities, including wage stickiness, in Finland. Hence, the empirical evidence suggests that labor frictions may be more relevant than tax shocks. Overall, we agree with Conesa et al (2007) that productivity and wage-wedge movements are necessary to explain the dynamics of macroeconomic aggregates; however, we interpret these movements as symptoms and argue that the Soviet trade shock may be the fundamental force behind these movements.

An additional observation that favors our trade-shocks approach is that industries exposed to the Soviet trade experienced a deeper downturn than industries not oriented to the Soviet market. This pattern is clearly reproduced by our model, while shocks other that the Soviet trade shock should be unable to generate this pattern in general. Figure 9 presents the scatter plot for export share to the USSR in 1988 and deviation of employment from trend in 1993 by industry. The slope of the OLS fitted line presented in the figure is -14.54 with standard error 6.4 which suggests a significant relationship between industry's exposure to the Soviet trade and its decline.[25] A one percentage point increase in the share of exports going to the Soviet Union is associated with a 1.4 percent decline in employment in 1993 relative to trend.

VI Extension to Transition Economies

There is ample evidence indicating that the trade and energy price shocks faced by the TEs of Eastern Europe and the former Soviet Union were at least as severe as those experienced by Finland. The practice of overpricing machines exported from CMEA countries to the Soviet Union and underpricing raw materials (mainly energy) exported from the Soviet Union to CMEA countries is well documented (e.g., Marrese and Vanous 1983). Orlowski (1993), Krasnov and Brada (1997) and others find the same pattern for intra-USSR trade. In addition, while there was 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), there is 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.

These observations suggest that our model may be useful in explaining the macroeconomic dynamics displayed by TEs in the early stages of transition. Our simulation results showed that the effects of eliminating the energy subsidy and Soviet trade relationship on output, employment and other aggregate outcomes are greatly amplified by real wage rigidities. Because of data limitations, it is hard to establish whether real wages were rigid in Eastern European countries in the initial stages of the transition. Initial estimates of the wage elasticity with respect to unemployment rates suggested that real wages were fairly flexible in TEs (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

[25] The estimate based on the Huber-robust regression, which downweighs outliers (e.g., non-metallic mineral products), is -17.6 with standard error 5.3.

Traistaru-Siedschlag 2005). In addition, labor markets in TEs appear to be as regulated as in other European countries (Botero et al 2004). On the other hand, it is hard to 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 incomplete and spread over time. 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.[27]

To support our hypothesis that the contraction observed in TEs can be explained with the oil price and trade shocks caused by the demise of the USSR, we would like to compare simulated transitional dynamics from the model (calibrated for TEs) with the data responses at the aggregate and sectoral levels (also for TEs). 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 choose these two countries because they embody two different strategies of adjustment in transition. Poland allowed a quick and deep adjustment of real wages, while in Hungary real wages had gradual and modest adjustment (see e.g. Tonin 2007).

We use the model and calibration from Sections III and IV as the basis of our analysis for transition economies. Since transition and Finnish economies were different, we need to make a

[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] Interestingly, the experience of East Germany after unification is broadly in line with our arguments for transition economies. East Germany was also dependent on cheap Soviet energy and overvalued exports to the USSR. Unification with West Germany brought not only world-class institutions to East Germany but also overvalued rigid wages for workers in East Germany. After reunification, East Germany experienced a severe downturn in economic activity. Similar to the Finnish experience, wages were rigid and reallocation of resources massive. Even after almost twenty years after the reunification, East Germany continues to lag behind West Germany in many economic dimensions. See Akerlof et al (1991) for more detailed discussion on East Germany and effects of high real wages.

few adjustments to the calibration. Since wages were more flexible in TEs than in Finland, we consider a range of values for θ. 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 the service sector was larger in Hungary.[28] Given that the energy intensity of output in the former socialist economies was twice as large as in the OECD economies (EBRD 2001), we also double a_1, a_2, a_3. These modifications in ξ's and a's 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.[29]

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 percent for Hungary and by 45 percent for Poland.[30] Consequently, we set the trade shocks to 45 percent for Poland and 60 percent for Hungary. Finally, we assume that the collapse of the Soviet trade occurred (or started to occur) in 1990 rather than 1991 as CMEA started to disintegrate before 1991.

Figure 10 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 responses of the Polish and Hungarian economies. The model can explain a bulk of the output contraction and the timing of the trough for both economies. The magnitude of the decline in the model depends on the speed of wage adjustment. In line with our model's prediction that

[28] 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.
[29] 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.
[30] Export statistics are taken from IMF Direction of Trade Statistics (DOTS) database. Other data sources (OECD, national statistical offices) report similar magnitudes.

greater wage inflexibility leads to deeper downturns, the model has a better fit to the data for Hungary when we use a higher value of θ which is consistent with the fact that Hungary had a slower wage adjustment than Poland. In any case, it is safe to say that even for relatively flexible wages the Soviet trade shock accounts for at least 50 percent of the contraction. Hence, this shock could have been a quantitatively important source of economic downturn in transition countries.

Although we do not have reliable data for many other transition countries, we can use fragmentary employment data to check whether adjustment of real wages is correlated with the response of employment in transition economies. Figure 11 displays a strong negative relationship between real wages and employment suggesting that countries with smaller declines in real wages experienced a larger contraction of employment between 1989 and 1995 which is consistent with our argument that incomplete adjustment of real wages could have contributed to the depth of downturn in transition economies.

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 the Soviet economy was militarized (15-20 percent of GNP according to various estimates, e.g. Steinberg (1992)) and had only limited ability to switch production to non-military goods. For example, the 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 transfer 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.

[31] 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.

VII Concluding Remarks

This paper examines the Finnish Great Depression of the early 1990s using a dynamic general equilibrium framework with labor frictions. Our analysis delivers two key results. First, we find that the Finnish Great Depression can be explained to a large extent by two exogenous shocks produced by the collapse of trade with the USSR (the surge in energy prices and the sudden redundancy of Soviet-oriented manufacturing). Since the identification of these shocks is particularly clear cut, this natural experiment evidently illustrates the behavior of a small open economy in response to large exogenous trade shocks. The key mechanism that amplified the initial trade shocks into a Great Depression was the rigid real wages in the Finnish economy. We show that our calibrated multi-sector model is successful in reproducing other historical episodes and produces estimates of trade shock effects which are supported by other pieces of evidence (in particular, macroeconomic performance in Sweden v. Finland and the response to the 1974 oil shock).

Second, our model can also account for the main features of the early 1990s adjustment observed in Eastern European transition economies, which displayed output dynamics and trade patterns similar to those observed in Finland. This similarity is particularly striking and calls for a reinterpretation of the sources of deep recessions in transition economies since Finland, in contrast to transition economies, had a well functioning system of markets, courts and other institutions. Although we cannot rule out alternative explanations for contractions in transition economies, the quantitative responses to the Soviet trade shock can account for a large share of the contraction in transition countries and Finland. In other words, the trade shocks we observe in the data could lead to economic downturns in standard theoretical multi-sector models which are remarkably close to the size of downturns we observe in transition economies. This important finding suggests that alternative explanations such as institutional transformations could have had a smaller effect than thought before.

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 and static measures of effects of trade shocks can grossly overestimate the short-run cost of reallocation.. Reallocation of resources can be particularly costly in presence of sticky wages and/or prices. The Finnish experience can also shed some new light on the post-WWII contractions after rapid changes in the composition of aggregate demand (e.g., disarmament in the U.S. after the Korean War). Likewise, we conjecture that our framework may be useful in analyzing the effects of the current economic downturn in the U.S. on its major trading partners such as Canada, Mexico, and China to the extent that their labor markets are rigid and the trade shock is protracted.

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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**
of which			
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
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	79.318	103.152	106.137
Share of employment	0.055	0.233	0.712
Share of value added	0.056	0.269	0.675
Share of exports in total exports	0.175	0.815	-
Ratio of energy cost to value added	0.049	0.052	0.035

Notes: 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 5 percent) by hours of work. Ratio of energy cost to value added computes the ratio of the cost of imported energy to value added in a given industry. We use the input-output table for 1989 to allocate of the cost of imported energy across sectors.

Table 3. Summary of calibrated parameters.

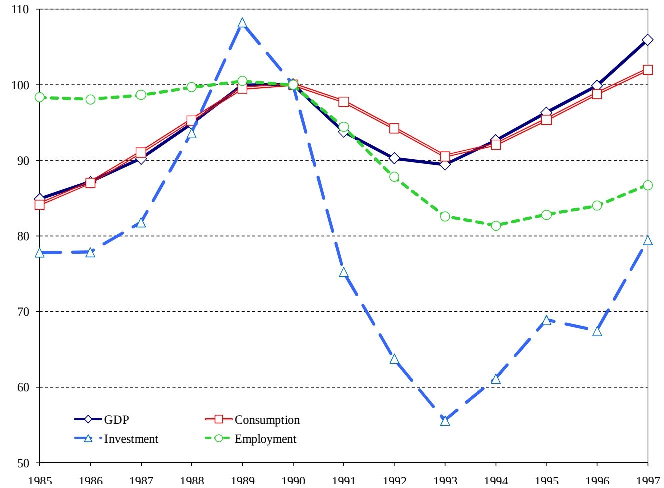
Panel A: Sectoral parameters	Soviet Sector	Non-soviet sector	Service sector	Foreign good
Consumption shares, ζ	0.04	0.15	0.54	0.27
Labor share, α_L	0.57	0.63	0.63	-
Disutility of labor supply,	1.65	0.40	0.13	-
Energy intensity, a	37.84	21.56	47.51	
Price of the final good	-	1	-	1
Wage rigidity, θ	0.99 (0,1)	0.99 (0,1)	0.99 (0,1)	-
Capital adjustment cost, φ	1	1	1	-
Investment adjustment cost, ψ	0 (0.5)	0 (0.5)	0 (0.5)	-
Labor adjustment cost, λ	0 (1)	0 (1)	0 (1)	

Panel B: Macroeconomic parameters	
Intertemporal elasticity of substitution parameter, σ	2 (5)
Labor supply elasticity parameter, η	1
Capital depreciation rate, δ	0.025
Discount factor, β	0.99
Elasticity of substation in consumption parameter, ρ_C	0 (-1,0.33)
Elasticity of substation in production parameter, ρ_P	0 (-1)
Returns to scale in production, γ	1 (0.95)
Price of oil, p^S	1
Habit formation in consumption, h	0 (0.8)

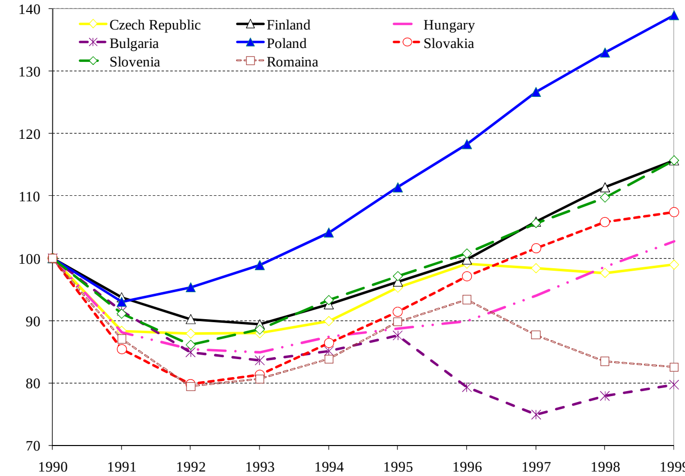
Notes: figures in parentheses show parameter values used in sensitivity analyses.

Figure 1. Macroeconomic dynamics in Finland.

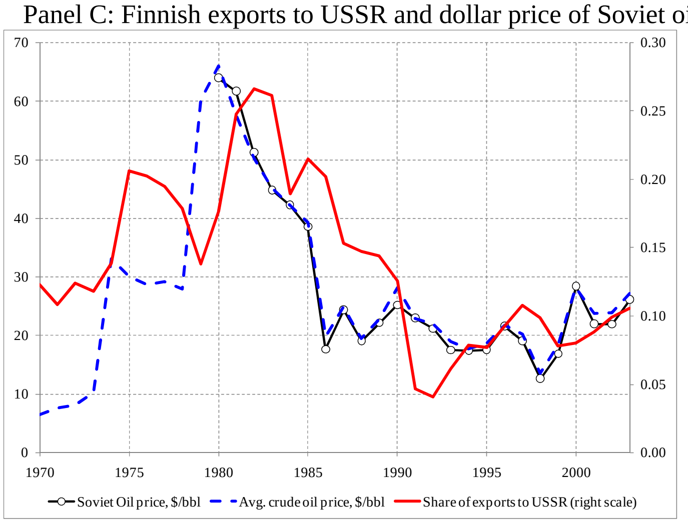
Panel A: Real GDP, Investment and Consumption in Finland.



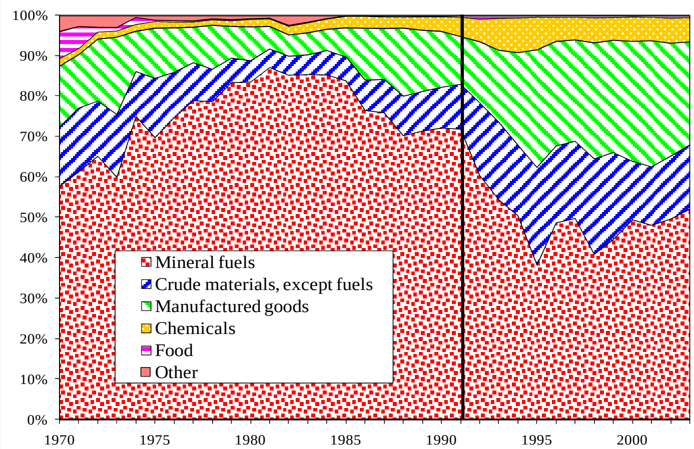
Panel B: Real GDP in Finland and Eastern Europe



Panel C: Finnish exports to USSR and dollar price of Soviet oil.



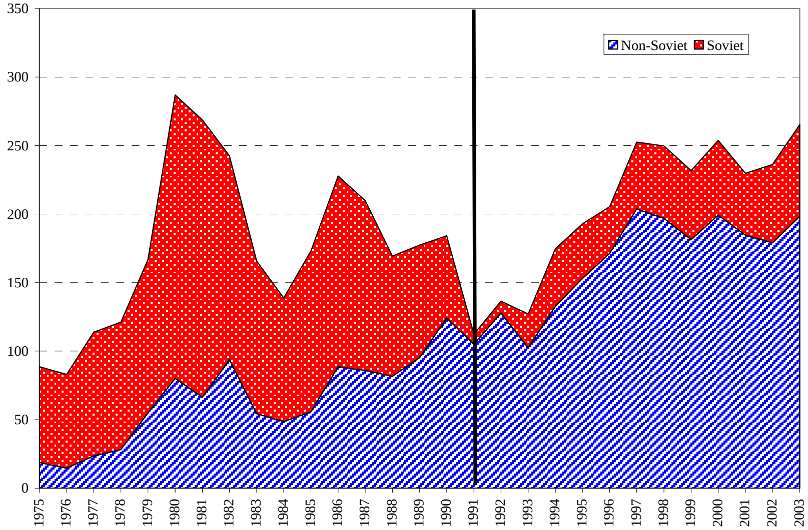
Panel D: Structure of Finnish imports from the USSR



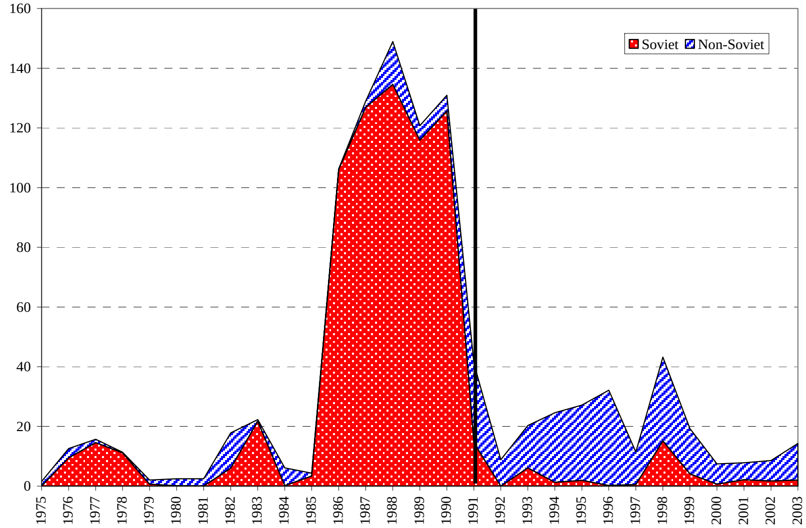
Notes: Panel A: Series are normalized to be equal 100 in 1990. The data are from *OECD* National Accounts database. Panel B: Series are normalized to be equal 100 in 1990. The data are from National Accounts Estimates of Main Aggregates, United Nations Statistics Division. Panel C: Soviet oil price series is from International Energy Agency. Average oil price is from IMF IFS. For post 1991 years, Soviet Union exports are computed as the sum of exports to the 15 republics of the former Soviet Union. The vertical line shows 1991. The data are from OECD, Finnish Ministry of Statistics, author's calculations. Panel D: For post 1991 years, Soviet Union exports are computed as the sum of exports to the 15 republics of the former Soviet Union. The vertical line shows 1991. The data are from OECD, Finnish Ministry of Statistics, author's calculations.

Figure 2. Soviet and non-Soviet exports for selected industries.

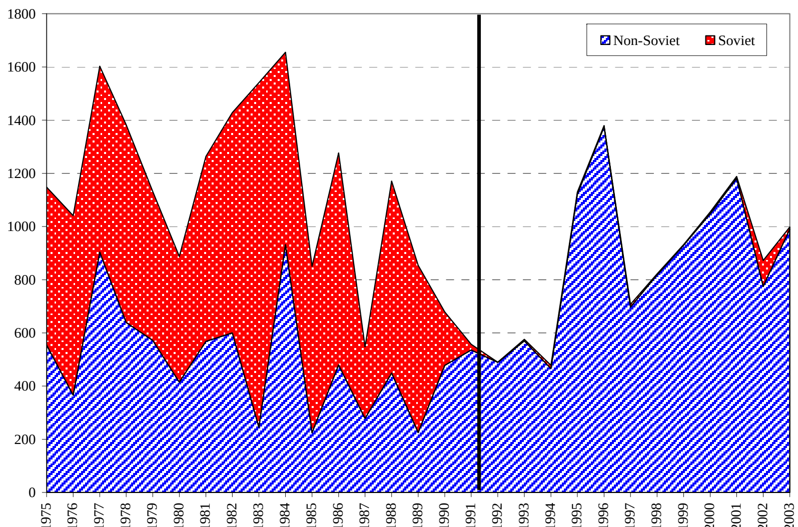
Panel A: Cable and wire



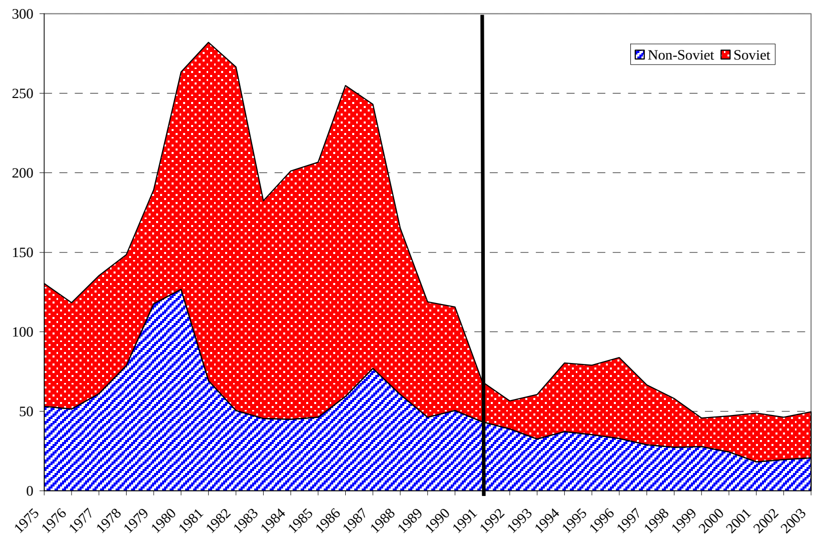
Panel B: Railroad equipment



Panel C: Shipbuilding



Panel D: Footwear

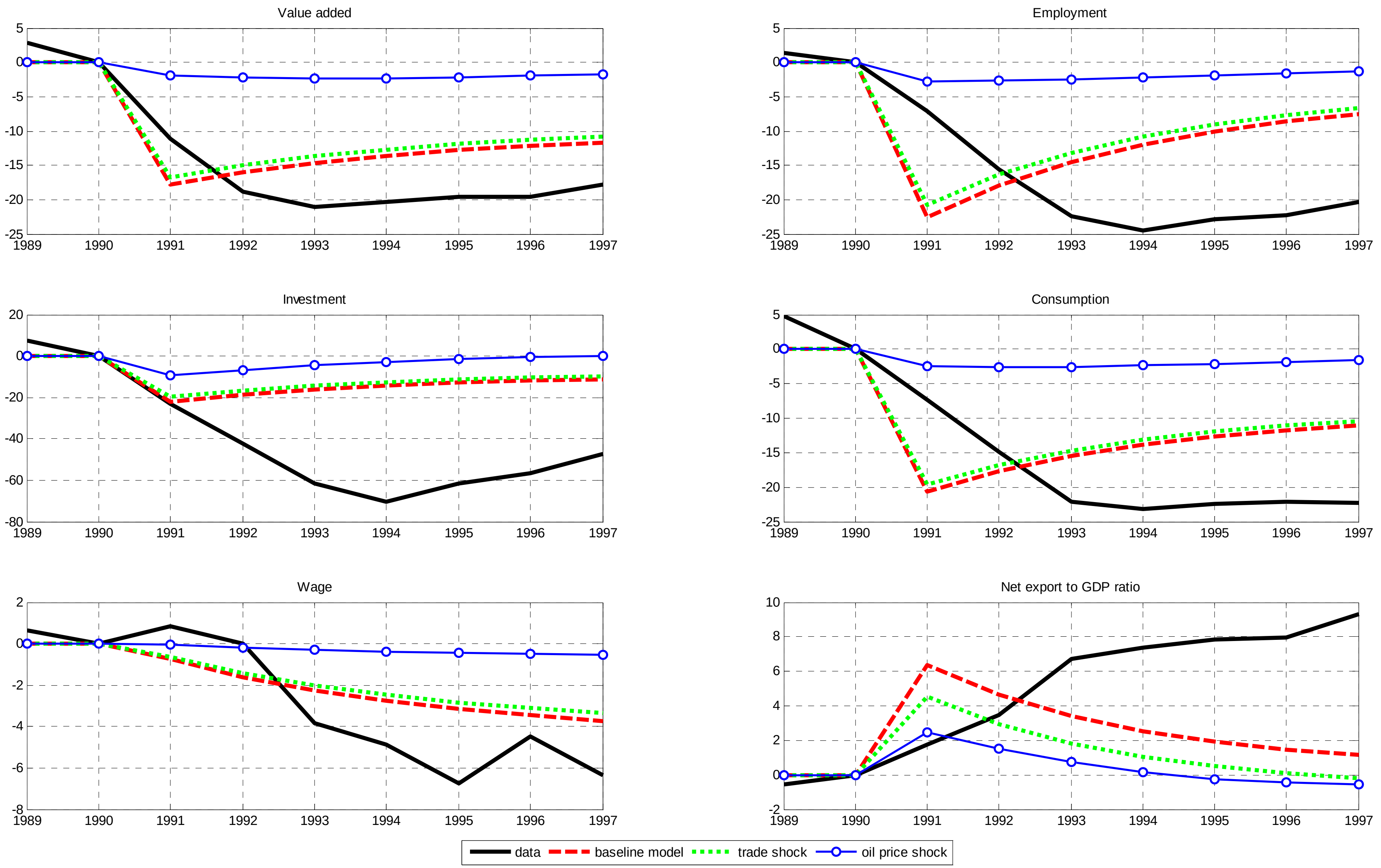


Notes: The stacked area charts display exports by destination, Soviet vs. non-Soviet. Combined area shows total exports. Exports are in thousands of fixed 2000 US dollars. For post 1991 years, Soviet Union exports are computed as the sum of exports to the 15 republics of the former Soviet Union.

Figure 3. Distribution of annual nominal wage growth by industry.

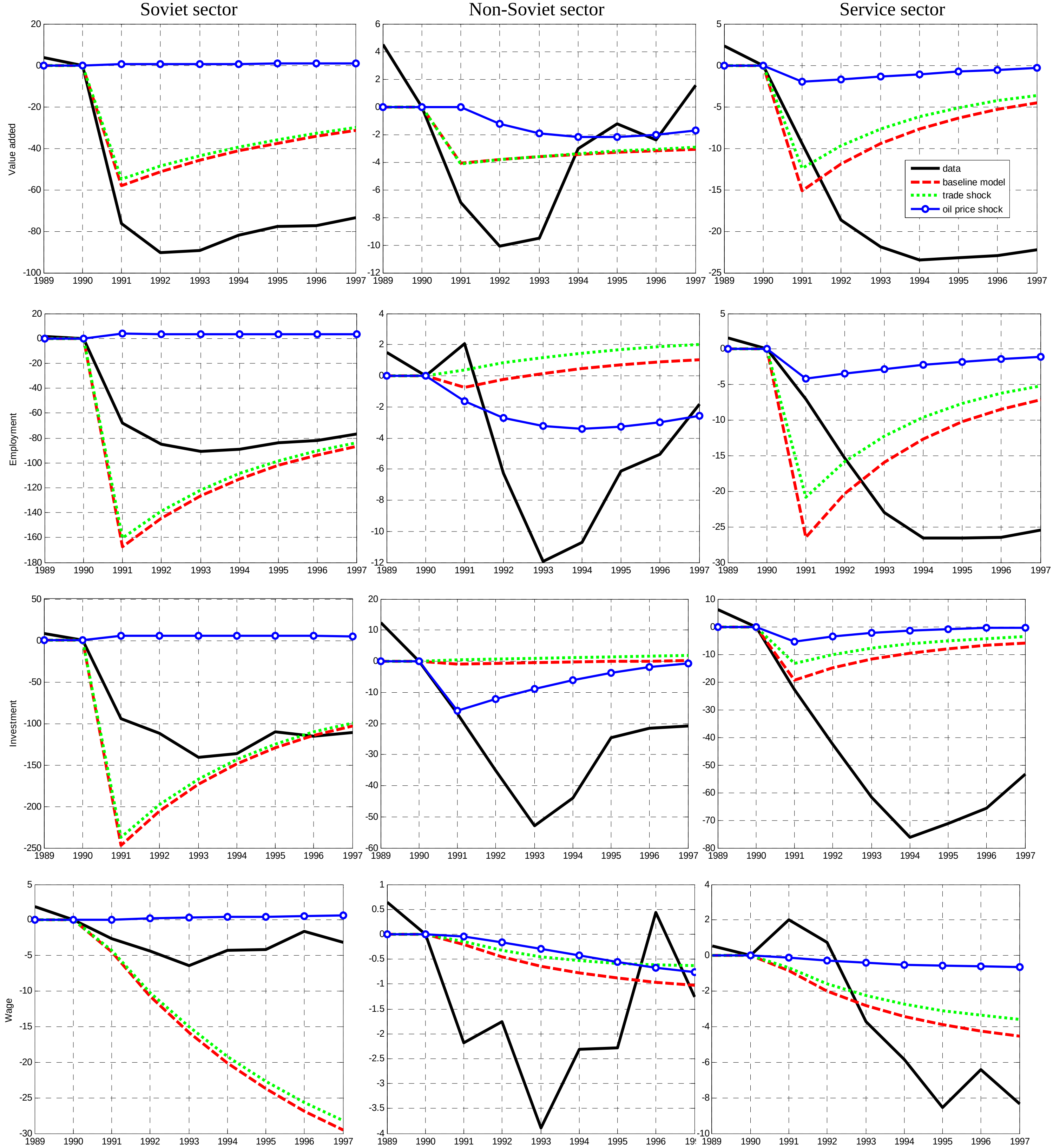
Notes: This figure reports distribution of individual workers' annual nominal wages. Vertical axis measures fraction. Horizontal axis measures percent change in annual nominal wages. The bar in blue indicates the level of inflation. Source: Bockerman, Laaksonen, and Vainiomaki (2006).

Figure 4. Macroeconomic aggregates: Simulated response to oil and trade shocks, percent deviations from trend. Baseline calibration.



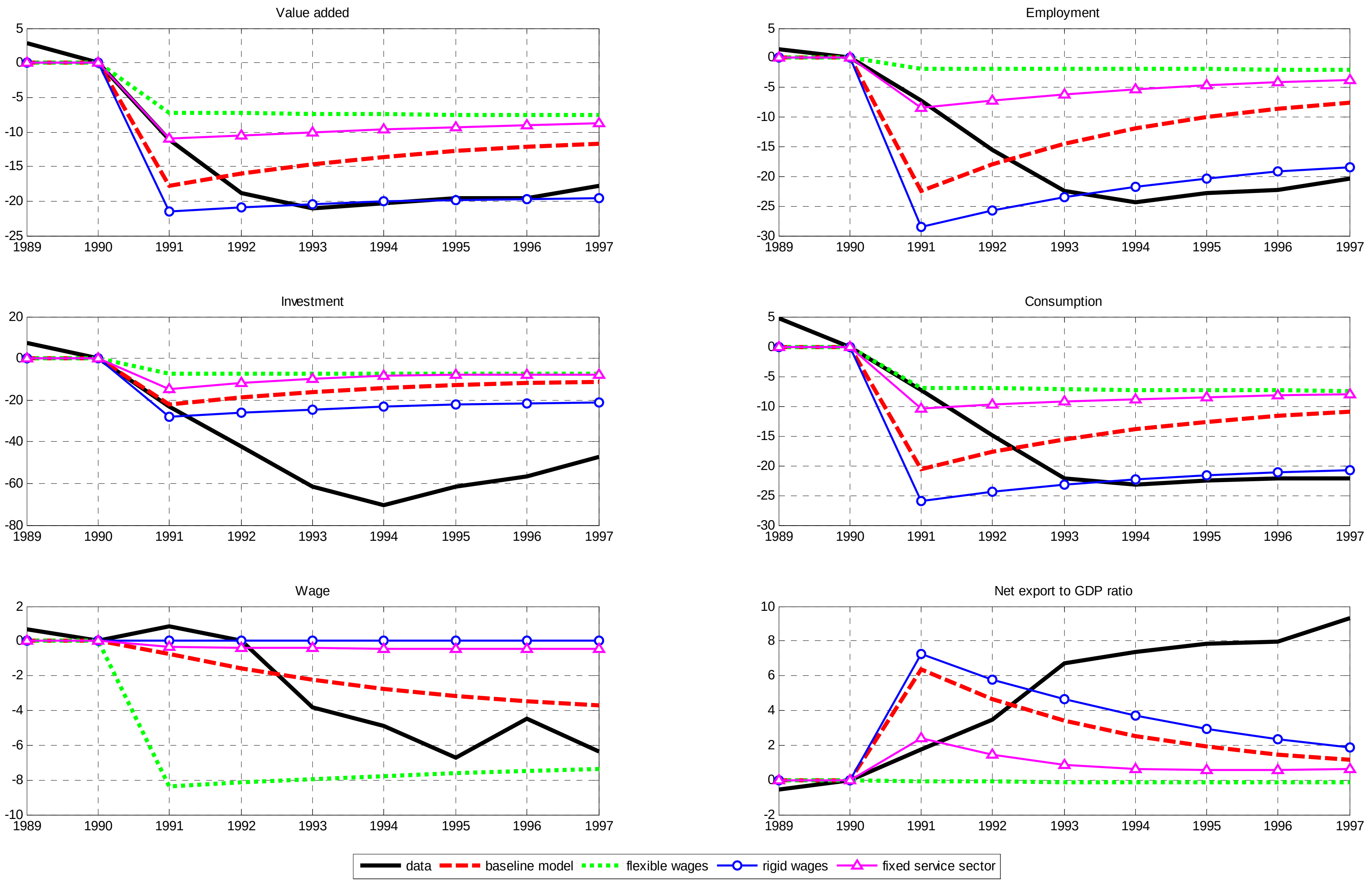
Notes: The figures plot percent deviations from 1990 value (for net export to GDP ratio) or trend (for all variables). See Appendix B for more details on detrending. Trade shock is the shock with corresponds to setting trade with USSR to zero while keeping the oil price constant. Oil price shock is the 10 percent increase in the oil price while keeping the volume of trade with the USSR constant.

Figure 5. Simulated response to oil and trade shocks, percent deviations from trend: Sectoral dynamics.



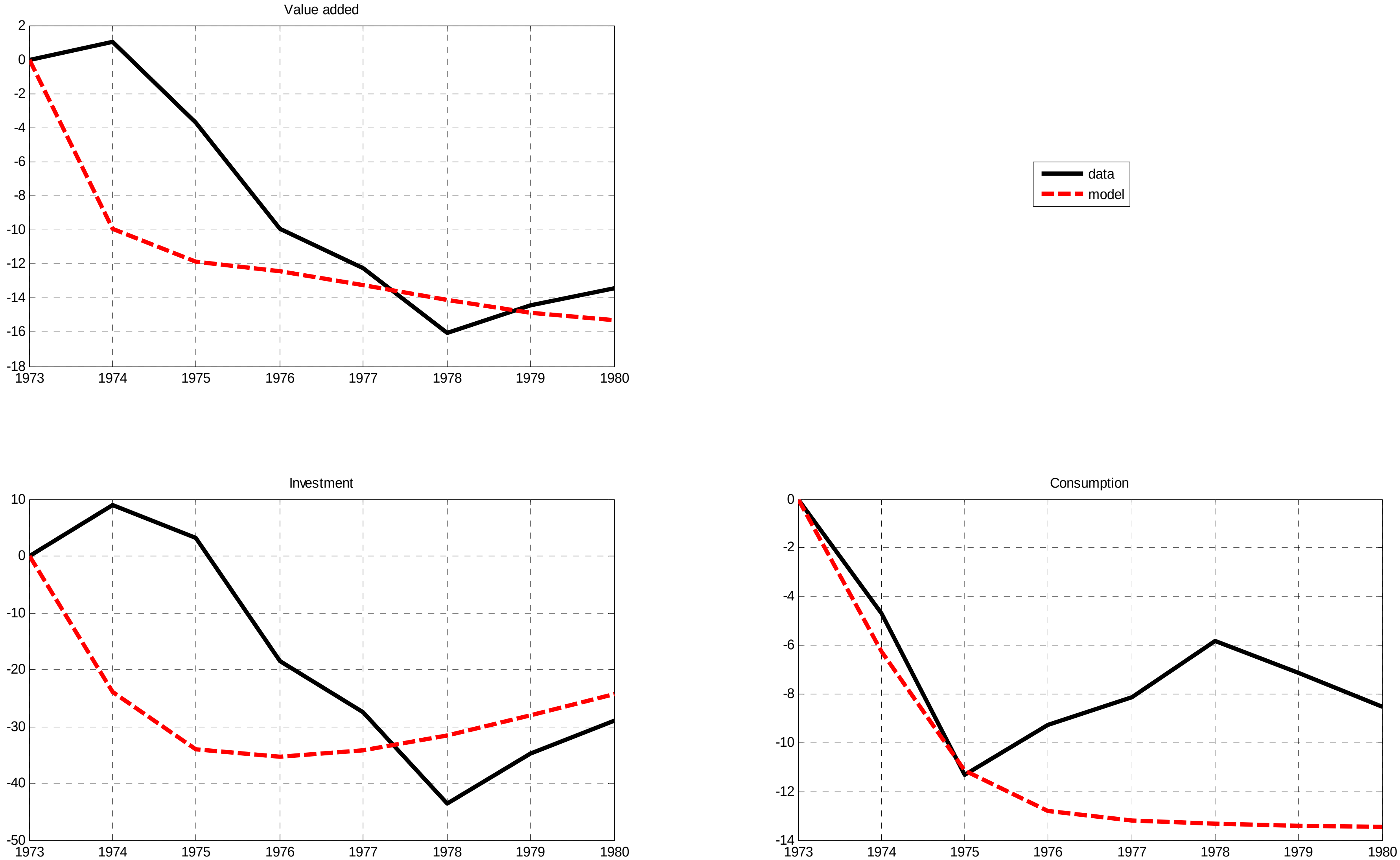
Notes: Baseline calibration. The figures plot percent deviations from trend for all variables. See Appendix B for more details on detrending. Trade shock is the shock with corresponds to setting trade with USSR to zero while keeping the oil price constant. Oil price shock is the 10 percent increase in the oil price while keeping the volume of trade with the USSR constant.

Figure 6. Macroeconomic aggregates, percent deviations from trend: Effects of wage rigidity and service sector.



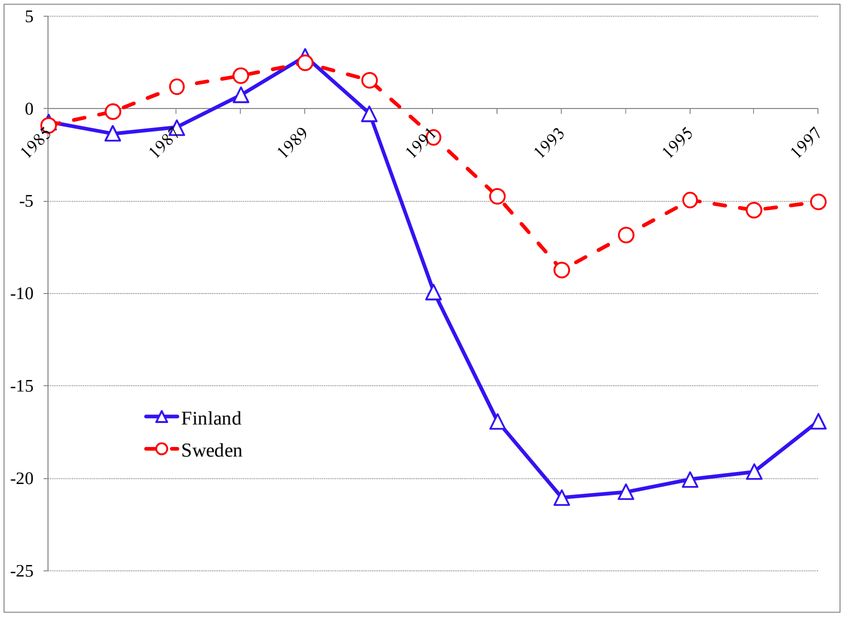
Notes: The figures plot percent deviations from 1990 value (for net export to GDP ratio) or trend (for all variables). See Appendix B for more details on detrending. Trade shock is the shock with corresponds to setting trade with USSR to zero while keeping the oil price constant. Oil price shock is the 10 percent increase in the oil price while keeping the volume of trade with the USSR constant. Scenario "flexible wages" sets $\theta_1 = \theta_2 = \theta_3 = 0$. Scenario "rigid wages" sets $\theta_1 = \theta_2 = \theta_3 = 0.99975$.Scenario "fixed service sectors" presents the response of the economy when we freeze the size as well as prices for the service (nontradabales) sector at the precollapse levels. In this scenraio, $\theta_1 = \theta_2 = \theta_3 = 0.99$.

Figure 7. Oil price shock in 1974, percent deviations from trend.



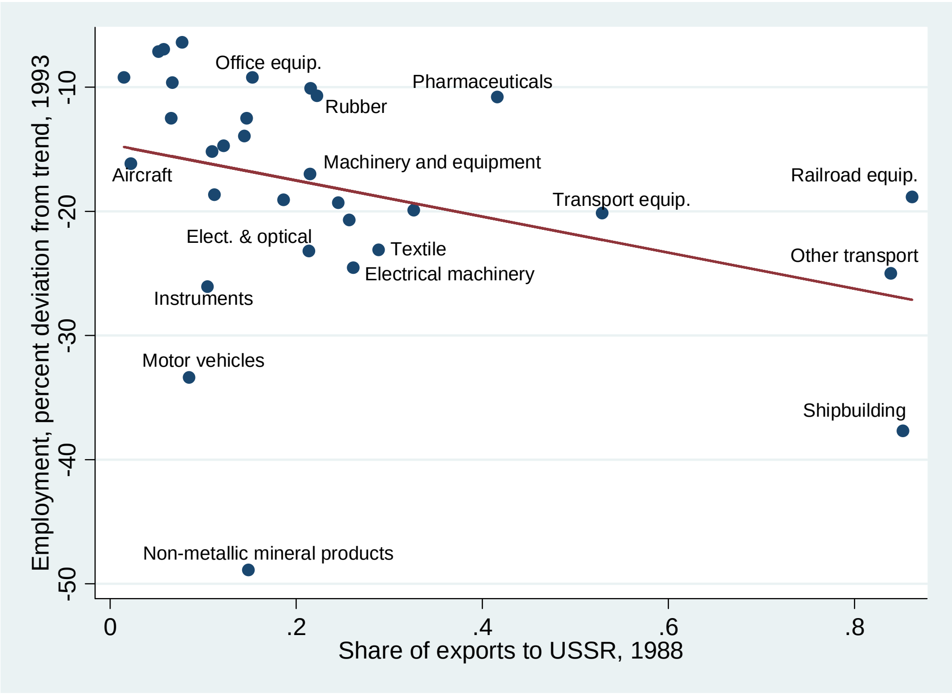
Notes: Solid line is the deviation of real GDP, real consumption, and real investment from the respective linear time trends estimated on 1950-1973 data. Real GDP, real consumption, and real investment (in 2000 prices) series are taken from Penn World Tables. The deviation adjusted to be zero in 1973. 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 8. Real GDP in Sweden and Finland, percent deviations from trend.



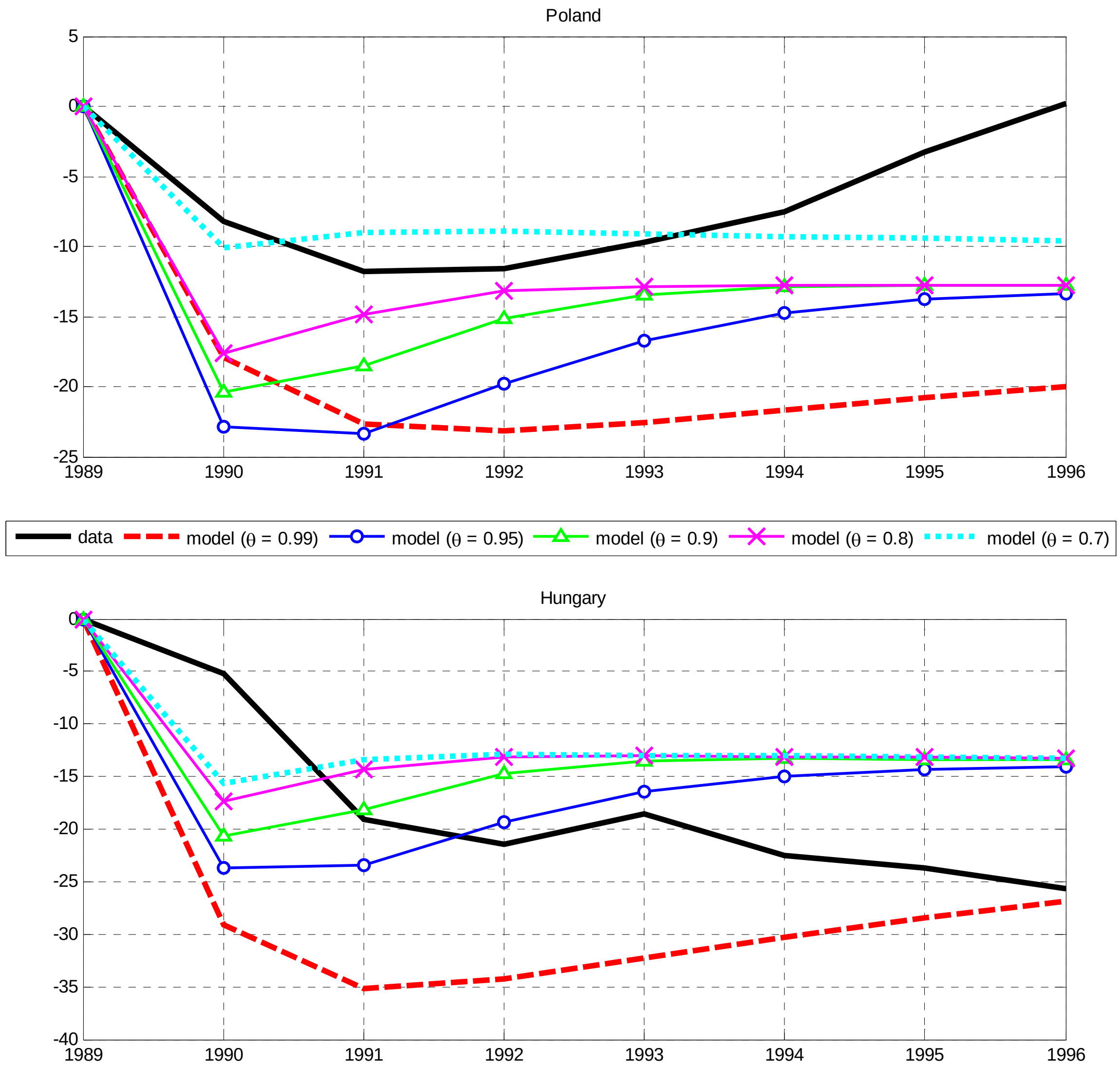
Notes: the figure reports percent deviations from trend estimated on 1970-1990 sample of GDP (in logs) time series.

Figure 9. Employment dynamics and exposure to Soviet trade, by industry.



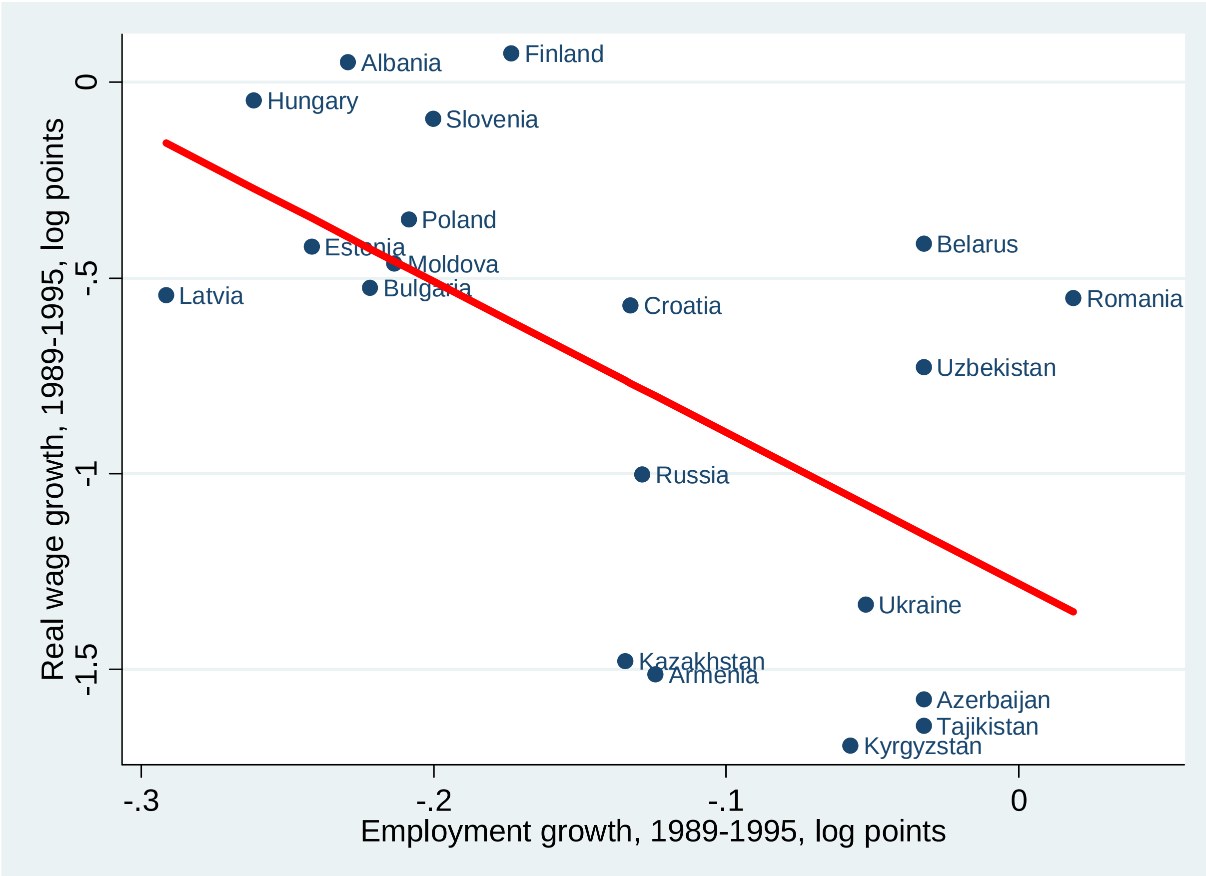
Notes: Deviation from trend for employment is computed as the log difference between actual value of employment in 1993 and predicted value for the trend estimated on 1980-1989 data. For shipbuilding and railroad equipment industries, the deviation is computed as the difference between employment in 1993 and 1989 because these industries had volatile time series. The slope of the OLS fitted line presented in the figure is -14.54 with standard error 6.4. (The slope of the Huber-robust fitted line is -17.6 with standard error 5.3.) Data are from STAN OECD.

Figure 10. Output dynamics in Poland and Hungary, percent deviations from trend.



Notes: 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. Other lines are simulated model responses. See text for further details.

Figure 11. Real wages and employment in transition economies.



Notes: real wages are computed as the ratio of average annual nominal wages to the average consumer prices index in the given year. Employment covers all sectors. The solid line shows the fit of the linear regression of the change in real wages on the change in employment. Data on employment, price level, and wages are from International Labor Organization, International Monetary Fund, and "10 Years of Commonwealth of Independent States" ("10 let Sodruzhestva Nezavisimykh Gosudarstv," published by the Russian Statistical Office in 2001). For countries in the Commonwealth of Independent States and Baltic countries, statistics are computed for 1991-1995 because consistent data prior to 1991 at the country level are not available.

Appendix A: Data sources

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 republics. 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. Service sector excludes public administration and defense as well as compulsory social security. Given constraints on matching consistent disaggregated production and export statistics, we use the following industries to construct Soviet and non-Soviet sectors:

- 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

Energy: Finnish statistical yearbooks (mainly for 1993) provide information on the cost and consumption of energy by industry. 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 B: Detrending and construction of sectoral data

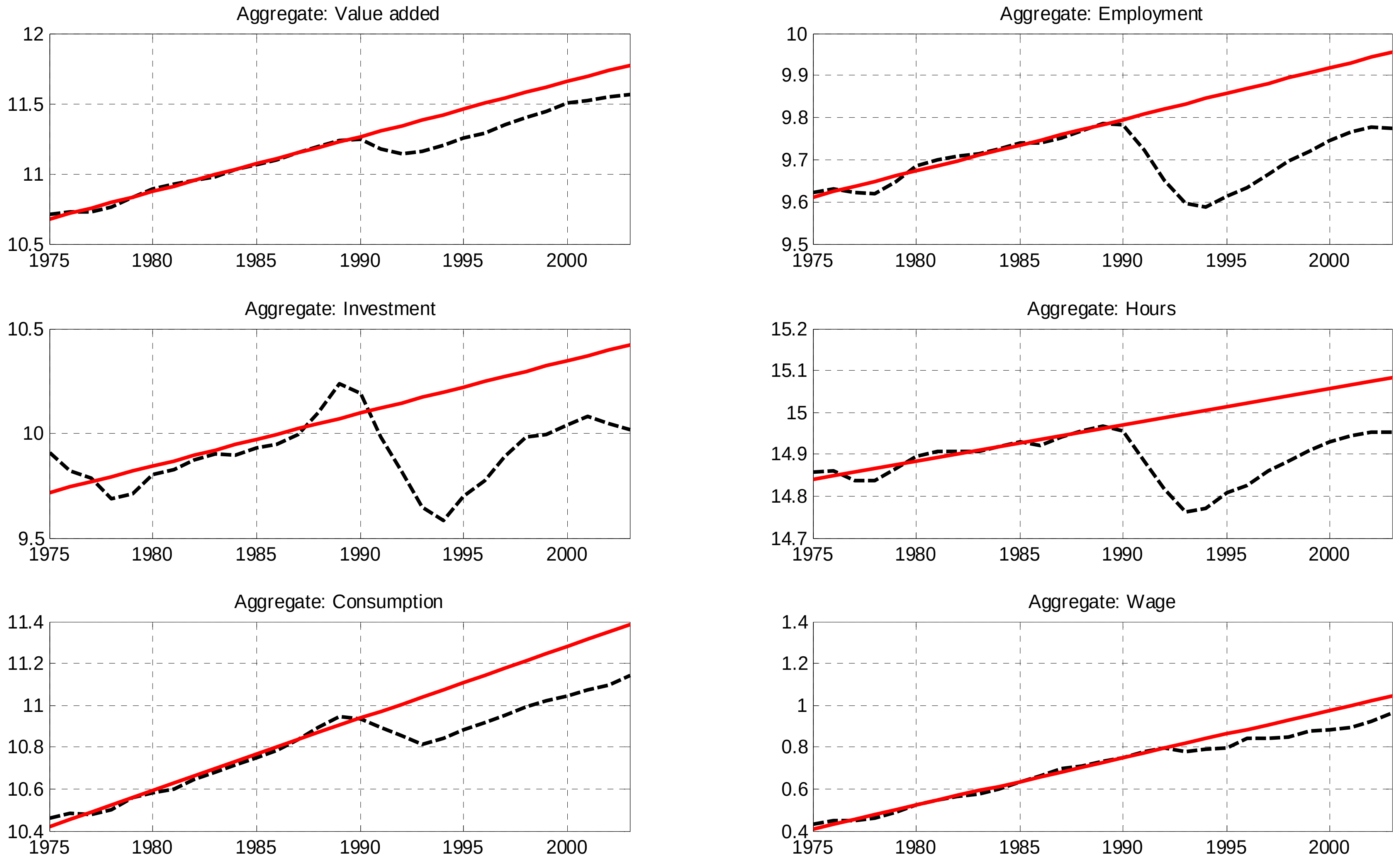
Since our study does not focus on long-run growth, we study macroeconomic aggregates after filtering out their long-run trend. Figure B1 plots the dynamics of the series and the fitted linear time trend. To exclude the effect of the post-Soviet period we use data only for 1975-1989 to fit the time trend. 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 Figure B3. Note that the detrended series exhibit a much stronger decline than the raw series. For example, real value added falls by 11 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 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 in Appendix A.

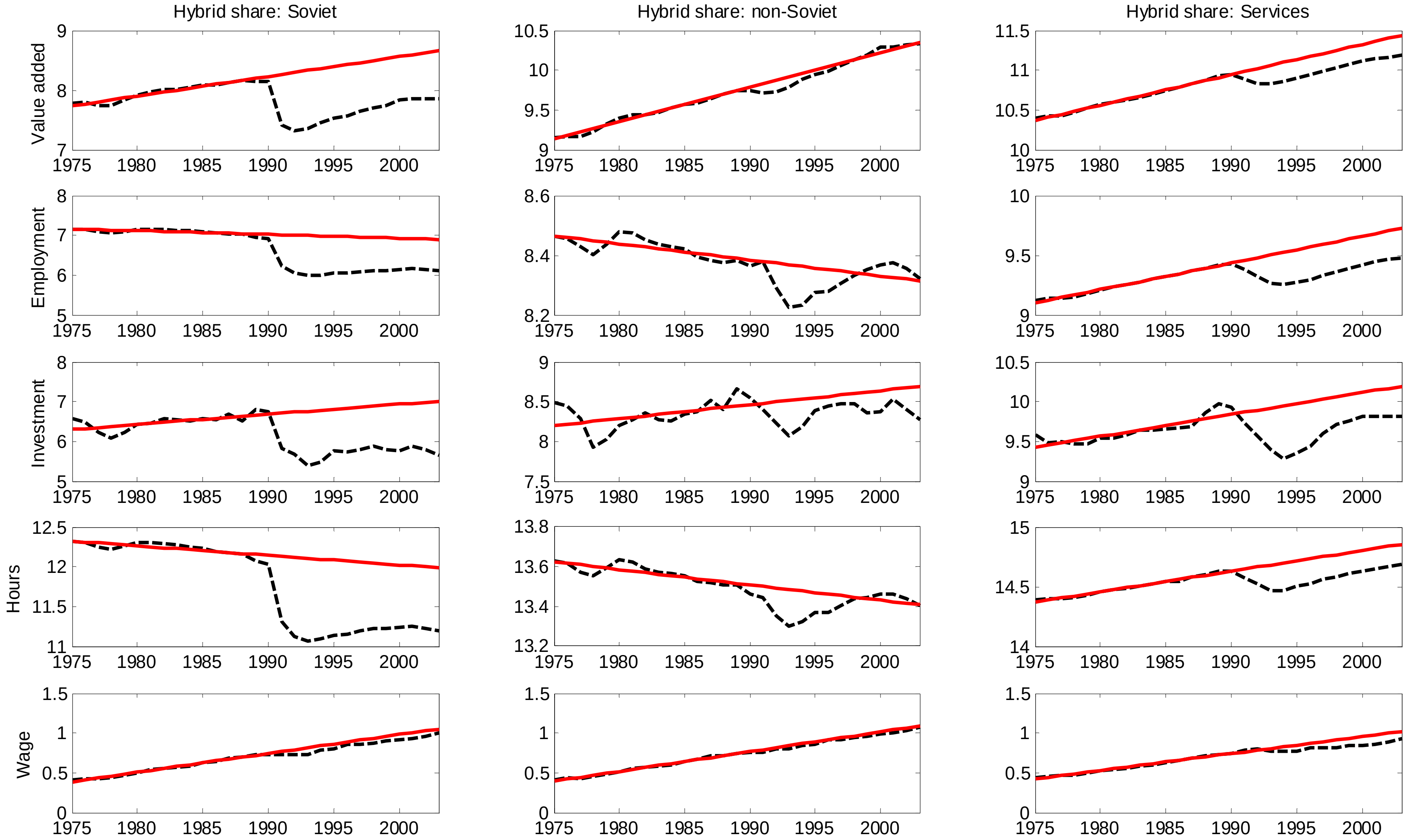
We plot series for Soviet, non-Soviet and service sector in Figure B2. Again, since most series grow over time we remove the trend component using a linear filter estimated on 1975-1989 data (Figure B3). We fit linear trend model to each series individually. We do not impose a common trend. The Soviet 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.

Figure B1. Macroeconomic aggregates: Actual series and estimated trend.



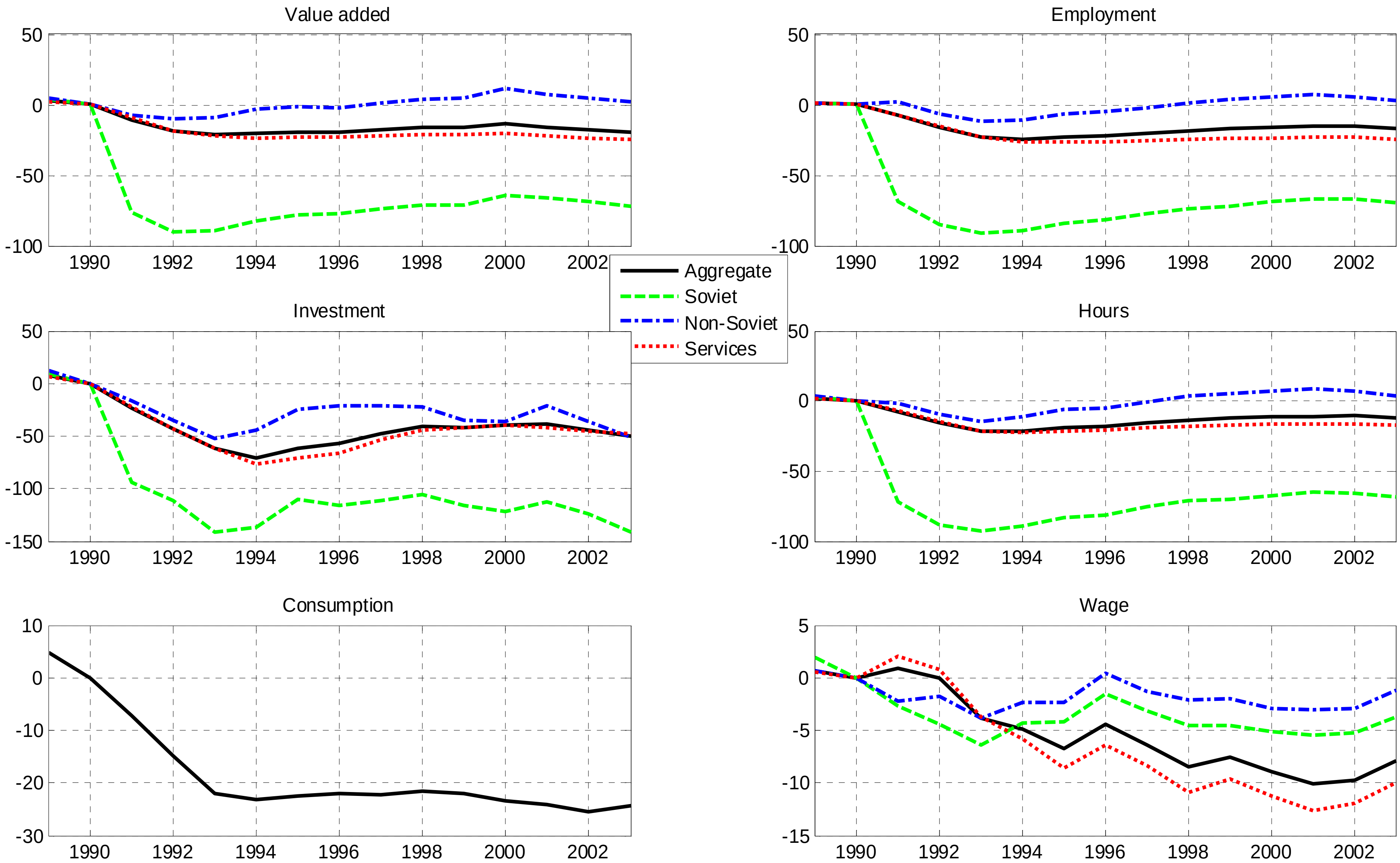
Note: The figure reports logs of real value added, real investment, real consumption, hours, and real wages. Solid line is time trend estimated on 1975-1989 data. Broken line is actual series.

Figure B2. 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.

Figure B3. Aggregate and sectoral series: percent 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 C: Calibration.

First, we calibrate elasticity of output with respect to inputs by utilizing data on cost shares

$$s_j^L \equiv \frac{\text{labor cost}_j}{\text{Value Added}_j} = \frac{w_j L_j}{p_j Q_j - a_j E_j} = \frac{p_j \alpha_{jL} (1-\frac{p_E}{p_j a_j}) Q_j}{p_j (1-\frac{p_E}{p_j a_j}) Q_j} = \alpha_{jL}$$

and hence $s_j^K = 1 - s_j^L$. Using data on wages (calculated as value added divided by hours of work) and on employment shares, we calibrate the disutility of labor. Specifically,

$$share_j^L \equiv \frac{L_j}{L_1 + L_2 + L_3} = \frac{(\frac{w_j}{\chi_j})^{1/\eta}}{(\frac{w_1}{\chi_1})^{1/\eta} + (\frac{w_2}{\chi_2})^{1/\eta} + (\frac{w_3}{\chi_3})^{1/\eta}} = \frac{(\frac{w_j}{w_1}\frac{\chi_1}{\chi_j})^{1/\eta}}{1 + (\frac{w_2}{w_1}\frac{\chi_1}{\chi_2})^{1/\eta} + (\frac{w_3}{w_1}\frac{\chi_1}{\chi_3})^{1/\eta}}$$

and hence $\chi_2 = \chi_1 \left(\frac{w_2}{w_1}\right)\left(\frac{share_1^L}{share_2^L}\right)^{\eta}$ and $\chi_3 = \chi_1 \left(\frac{w_3}{w_1}\right)\left(\frac{share_1^L}{share_3^L}\right)^{\eta}$.

Using cost share and relative wages, we can link employment shares to output shares

$$share_j^Y \equiv \frac{Y_j}{Y_1 + Y_2 + Y_3} = \frac{L_j w_j / \alpha_{jL}}{\sum_{i=1}^{3} L_i w_i / \alpha_{iL}} = \frac{(\frac{w_j}{w_1})\frac{share_j^L}{\alpha_{jL}}}{1 + (\frac{w_2}{w_1})\frac{share_2^L}{\alpha_{2L}} + (\frac{w_3}{w_1})\frac{share_3^L}{\alpha_{3L}}}$$

and verify that output shares are consistent with employment shares and relative wages.

We can also impute prices of Soviet and service goods using wages and capital/labor ratios. Note that we can combine first order conditions for capital and labor to get

$$\frac{\alpha_{1L}}{\alpha_{1K}}\frac{K_1}{L_1} = w_1, \; p_2 \frac{\alpha_{2L}}{\alpha_{2K}}\frac{K_2}{L_2} = w_2, \; p_3 \frac{\alpha_{3L}}{\alpha_{3K}}\frac{K_3}{L_3} = w_3$$

and therefore $p_2 = \frac{w_2}{w_1} \times \frac{(\frac{\alpha_{1L}}{\alpha_{1K}}\frac{K_1}{L_1})}{(\frac{\alpha_{2L}}{\alpha_{2K}}\frac{K_2}{L_2})}, \quad p_3 = \frac{w_3}{w_1} \times \frac{(\frac{\alpha_{1L}}{\alpha_{1K}}\frac{K_1}{L_1})}{(\frac{\alpha_{3L}}{\alpha_{3K}}\frac{K_3}{L_3})}$.

Given the implied prices of goods, we can compute the energy requirements from:

$$\text{Energy Requirement} \equiv ER_j \equiv \frac{p_E E_j}{Q_j (p_j - p_E / a_j)} = \frac{p_E Q_j / a_j}{Q_j (p_j - p_E / a_j)} \Rightarrow a_j = \frac{p_E (1 + ER_j)}{p_j ER_j}.$$

The implied share of Soviet export in total export is given by:

$$\frac{p_2 X_{2j}}{X_1 + p_2 X_{2j}} = \frac{p_E (E_1 + E_2 + E_3)}{p_E (E_1 + E_2 + E_3) + X_1} = \frac{\frac{p_E VA_1}{(a_1 - p_E)} + \frac{p_E VA_2}{(p_2 a_2 - p_E)} + \frac{p_E VA_3}{(p_3 a_3 - p_E)}}{\frac{p_E VA_1}{(a_1 - p_E)} + \frac{p_E VA_2}{(p_2 a_2 - p_E)} + \frac{p_E VA_3}{(p_3 a_3 - p_E)} + \frac{VA_1}{(1 - p_E / a_1)} \times \frac{(\zeta_4/\zeta_1)}{1 + (\zeta_4/\zeta_1)} \times [1 - \frac{\beta (1 - p_E / a_1) \alpha_{1K} \delta}{1 - \beta (1 - \delta)}]}$$

$$= \frac{\frac{p_E share_1^Y}{(a_1 - p_E)} + \frac{p_E share_2^Y}{(p_2 a_2 - p_E)} + \frac{p_E share_3^Y}{(p_3 a_3 - p_E)}}{\frac{p_E share_1^Y}{(a_1 - p_E)} + \frac{p_E share_2^Y}{(p_2 a_2 - p_E)} + \frac{p_E share_3^Y}{(p_3 a_3 - p_E)} + \frac{share_1^Y}{(1 - p_E / a_1)} \times \frac{(\zeta_4/\zeta_1)}{1 + (\zeta_4/\zeta_1)} \times [1 - \frac{\beta (1 - p_E / a_1) \alpha_{1K} \delta}{1 - \beta (1 - \delta)}]}$$

Hence, we can calibrate key parameters of the model using data cost shares, employment shares, wages, and capital/labor ratios.

Appendix D: Sensitivity analysis

In a more general specification of the model we allow for habit formation in consumption and adjustment costs in labor and investment. Specifically, the household optimization problem has a more general utility function:

$$U \equiv \sum_{t=0}^{\infty} \beta^t U(G_t, L_{1t}, L_{2t}, L_{3t}) \text{ with } G_t = \left\{ \zeta_1 \bar{C}_{1t}^{\rho_C} + \zeta_2 \bar{C}_{2t}^{\rho_C} + \zeta_3 \bar{C}_{3t}^{\rho_C} + \zeta_4 \bar{C}_{4t}^{\rho_C} \right\}^{1/\rho_C}$$

where $\bar{C}_{jt} = \frac{1}{1-h_j} C_{jt} - \frac{h_j}{1-h_j} C_{j,t-1}$ is the habit-adjusted consumption for good *j*, and parameter h_j describes habit in consuming good *j*.

In the firm's profit maximization problem, the generalization amounts to the following modification in the objective function

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

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

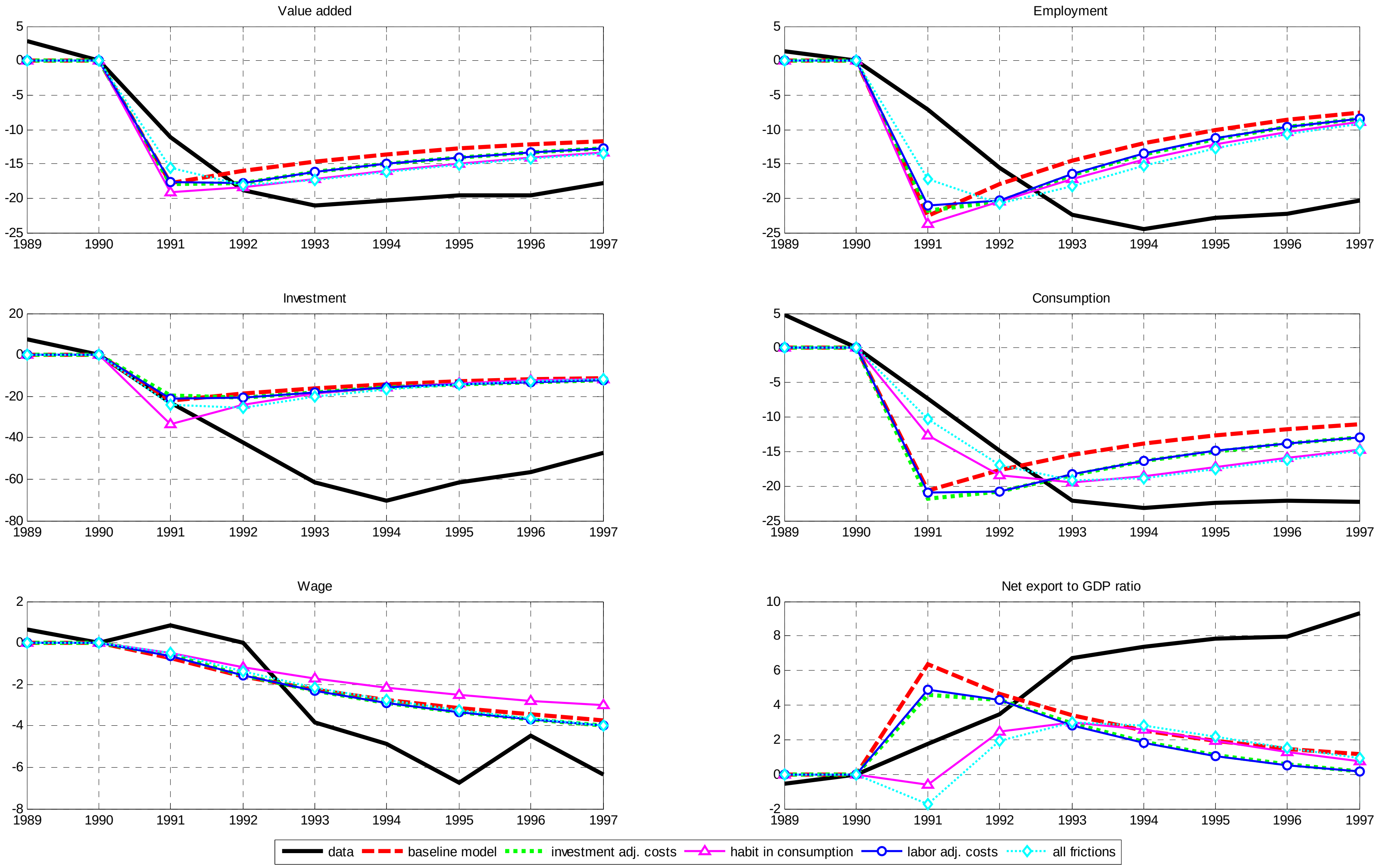
We assume small to moderate adjustment costs in labor: $\lambda_1=\lambda_2=\lambda_3=1$. Christiano, Eichenbaum and Evans (2005) report that investment adjustment costs are necessary to explain the response of macroeconomics aggregates to supply side shocks. We follow these authors and introduce a small quadratic 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 $h_1= h_2=h_3=0.8$.

We also consider an alternative functional form for the labor supply for different sectors. In particular, we examine how the choice of ρ_L (which controls the elasticity of substitution of labor supply across sectors $1/(\rho_L - 1)$) affects impulse responses:

$$U(G_t, L_{1t}, L_{2t}, L_{3t}) = \frac{1}{1-\sigma} \left(G_t - \frac{\chi_1}{\eta+1} (\omega_1 L_{1t}^{\rho_L} + \omega_2 L_{2t}^{\rho_L} + \omega_3 L_{3t}^{\rho_L})^{\frac{\eta+1}{\rho_L}} \right)^{(1-\sigma)}$$

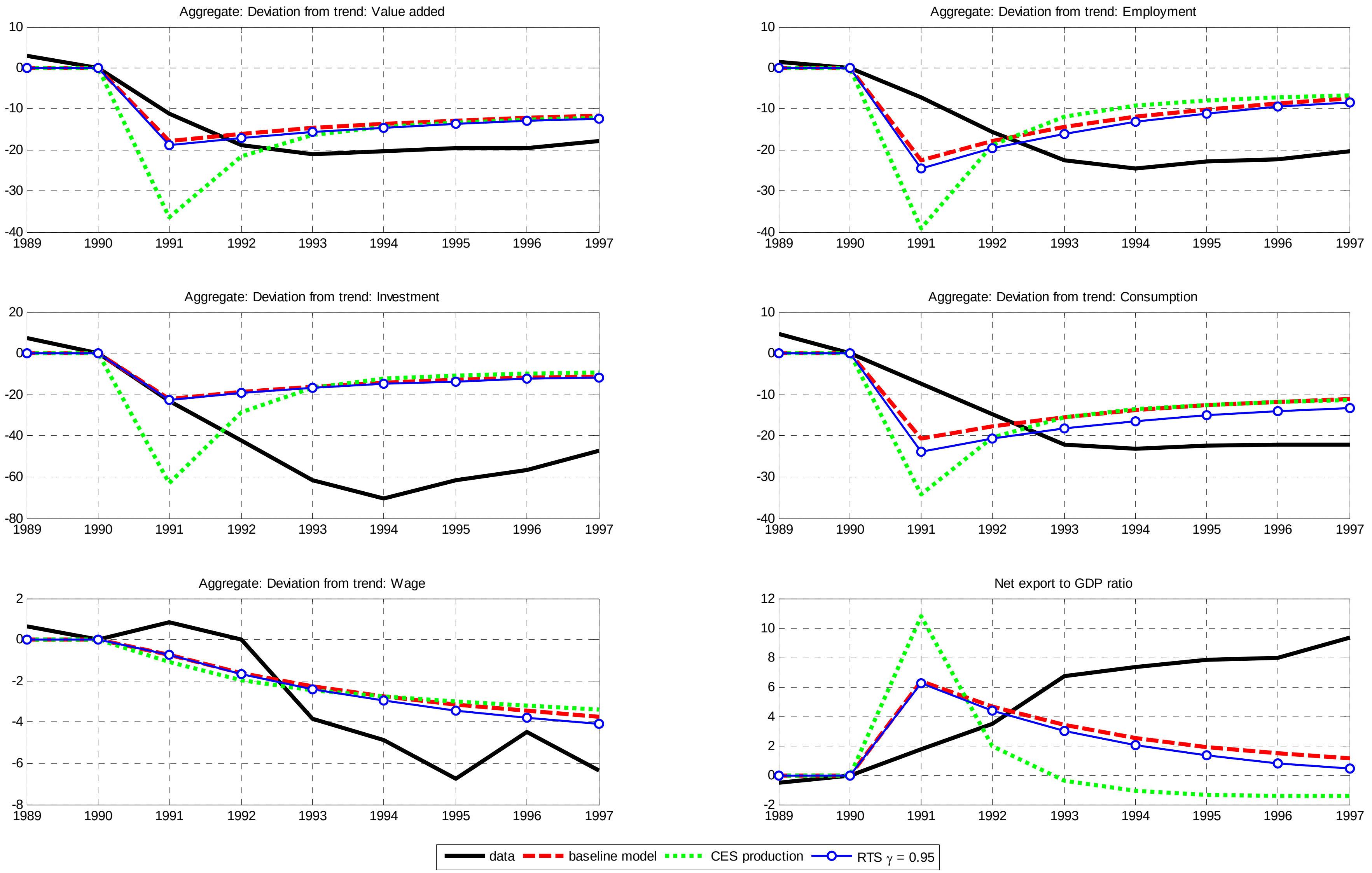
From the first order conditions and our baseline calibration of labor supply elasticity being equal to $\eta = 1$, one can find that our baseline formulation of the model is approximately recovered when $\rho_L = 2$.

Figure D1. Macroeconomic aggregates: Effects of adjustment costs and habit formation, percent deviations from trend.



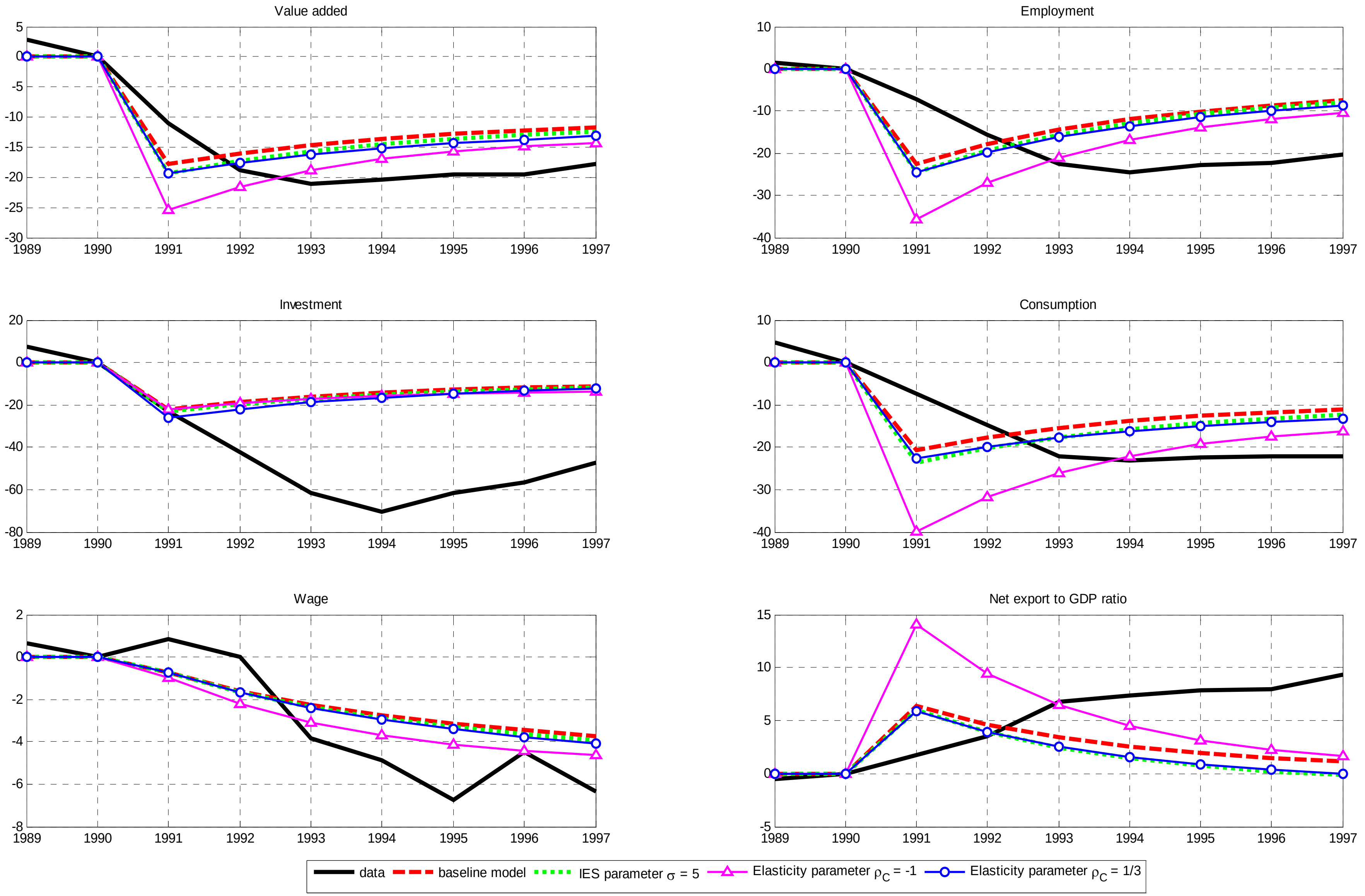
Notes: The figures plot percent deviations from 1990 value (for net export to GDP ratio) or trend (for all variables). See Appendix B for more details on detrending. Trade shock is the shock with corresponds to setting trade with USSR to zero while keeping the oil price constant. Oil price shock is the 10 percent increase in the oil price while keeping the volume of trade with the USSR constant. Scenario "all frictions" includes habit formation in consumption (h = 0.8 for types of consumption goods), investment adjustment costs (ψ=0.5 in all sectors), and labor adjustment costs (λ=1 in all sectors).

Figure D2. Macroeconomic aggregates: Effects of production function parameters, percent deviations from trend.



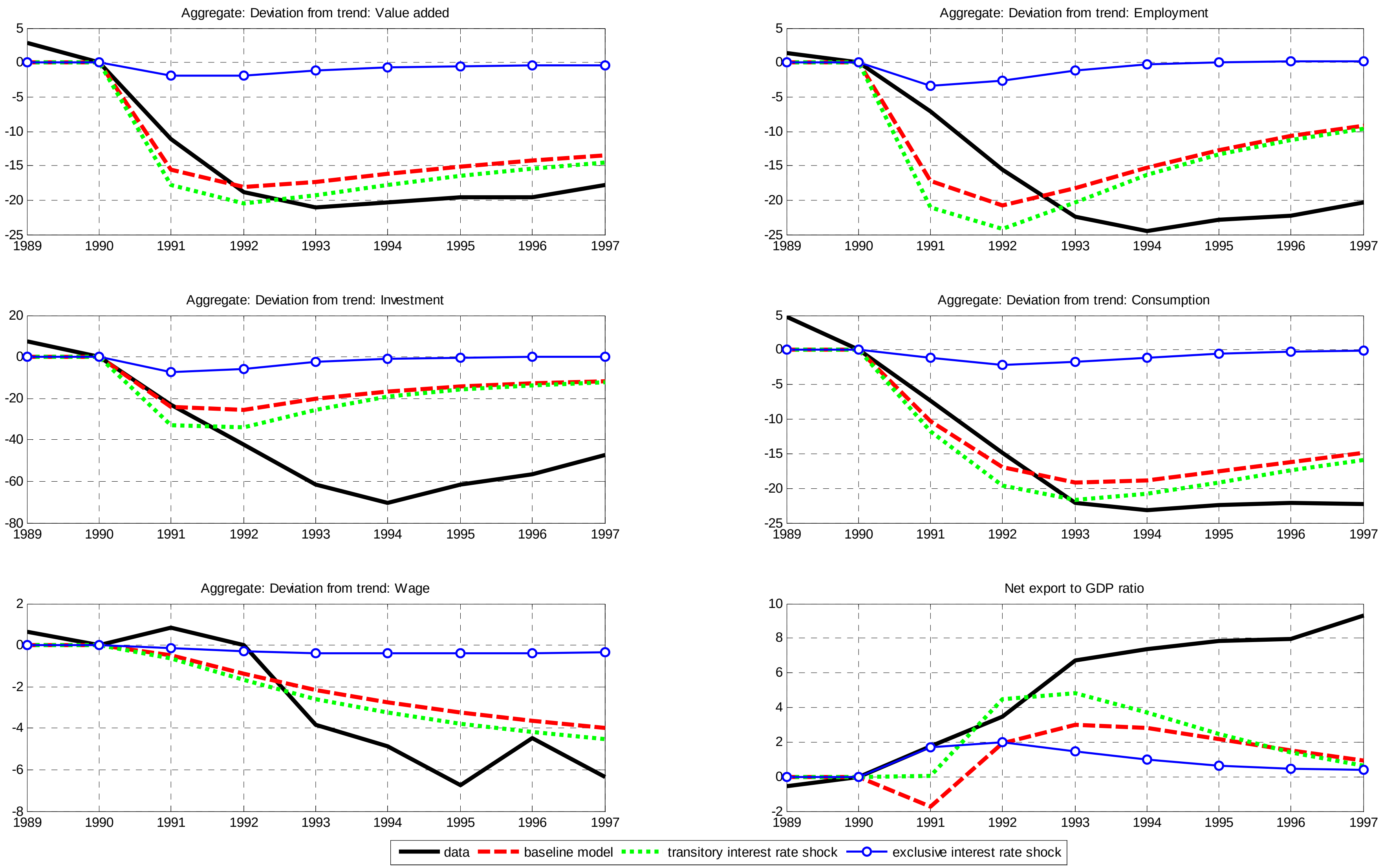
Notes: The figures plot percent deviations from 1990 value (for net export to GDP ratio) or trend (for all variables). See Appendix B for more details on detrending. Trade shock is the shock with corresponds to setting trade with USSR to zero while keeping the oil price constant. Oil price shock is the 10 percent increase in the oil price while keeping the volume of trade with the USSR constant. Scenario "CES production" assumes CES production function in all sectors with elasticity of substitution between capital and labor equal to 0.5. Scenario "RTS γ =0.95" sets returns to scale in each sector equal to 0.95.

Figure D3. Macroeconomic aggregates: Effects of consumption parameters, percent deviations from trend.



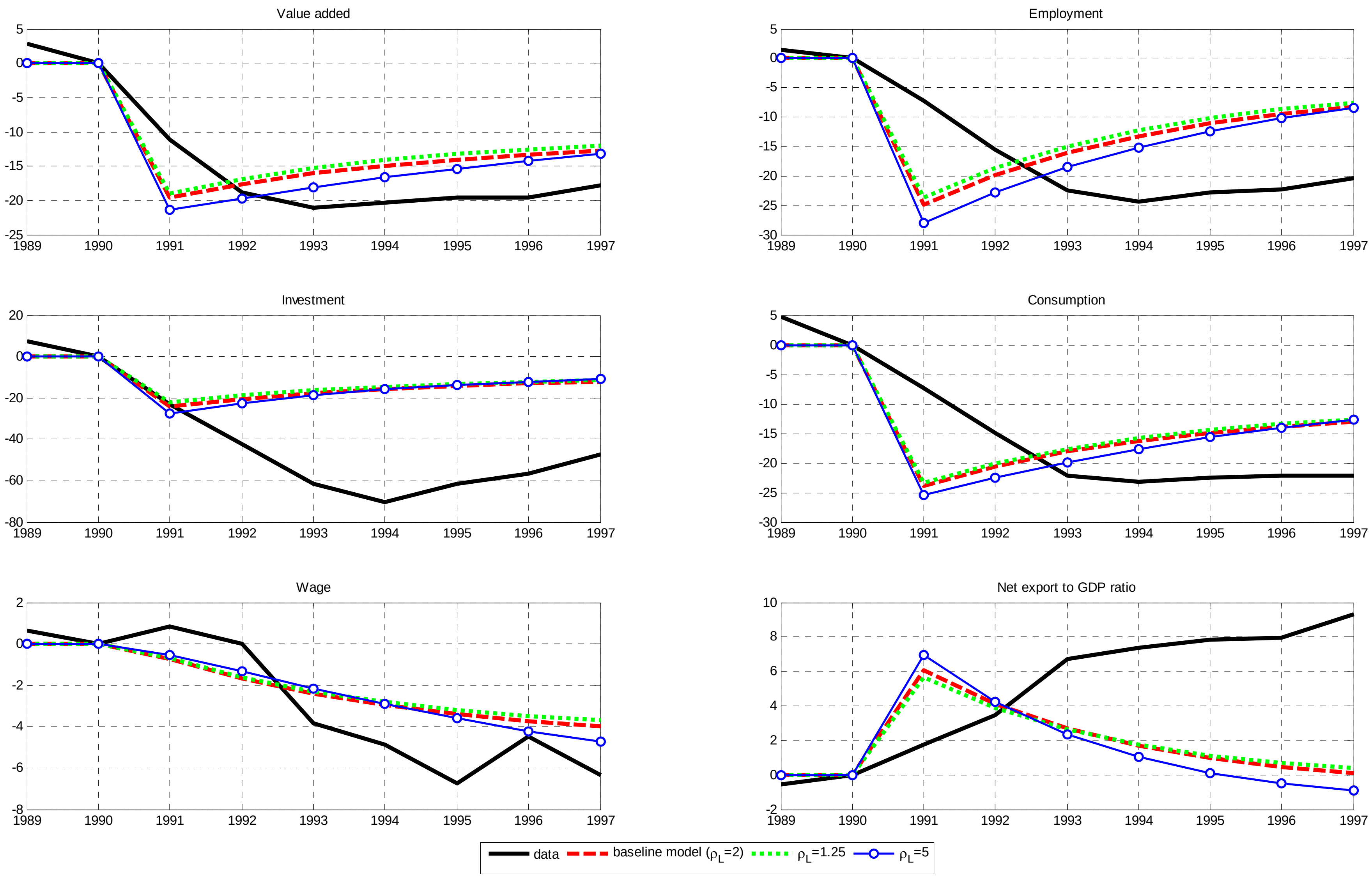
Notes: The figures plot percent deviations from 1990 value (for net export to GDP ratio) or trend (for all variables). See Appendix B for more details on detrending. Trade shock is the shock with corresponds to setting trade with USSR to zero while keeping the oil price constant. Oil price shock is the 10 percent increase in the oil price while keeping the volume of trade with the USSR constant. Scenario "IES parameter σ = 5" corresponds to setting intertemporal elasticity of substitution to 1/5. Scenario "Elasticity parameter ρ_C = -1" corresponds to setting the elasticity of substation across consumption goods (in the consumption aggregator) equal to ½. Scenario "Elasticity parameter ρ_C = 0.33" corresponds to setting the elasticity of substation across consumption goods (in the consumption aggregator) equal to 1.5.

Figure D4. Macroeconomic aggregates: Interest rate shock, percent deviations from trend.



Notes: The figures plot percent deviations from 1990 value (for net export to GDP ratio) or trend (for all variables). See Appendix B for more details on detrending. Trade shock is the shock with corresponds to setting trade with USSR to zero while keeping the oil price constant. Oil price shock is the 10 percent increase in the oil price while keeping the volume of trade with the USSR constant. All models include frictions such as habit formation in consumption (h = 0.8 for types of consumption goods), investment adjustment costs (ψ=0.5 in all sectors), and labor adjustment costs (λ=1 in all sectors).

Figure D5. Macroeconomic aggregates: Effects of substitutability of labor supply, percent deviations from trend.



Notes: The figures plot percent deviations from 1990 value (for net export to GDP ratio) or trend (for all variables). See Appendix B for more details on detrending. The model responses correspond for values for the parameter ρ_L which controls the elasticity of substitution across different types of labor. Specifically, the elasticity is given by (1/(ρ_L - 1)).

Appendix E: Auxiliary tables and figures.

Table E1. 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 = **D** × **F**(-1) × **H**			-661	-3529
N Terms of trade effect = **A** × (**C** – **B**)			1,522	-1,376
R Removal of subsidy effect = ½ × **J** × **K** ×**L**			-5.8	0.8
Total loss of income = **M** + **N** + **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

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

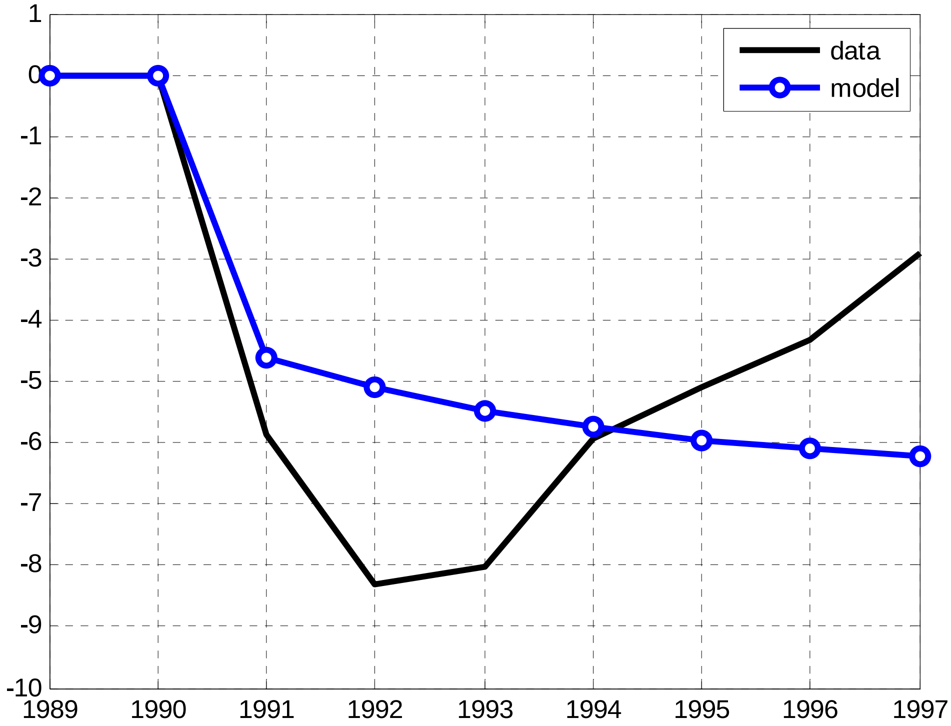
Table E2. Wage bargaining agreements.

Year	Agreement	Period of validity	Increase effective from	General Increase %	General Increase p/hour	Minimum and low-pay increase %	Average increase[32] %	Reforms Related to Centralized Agreement
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).

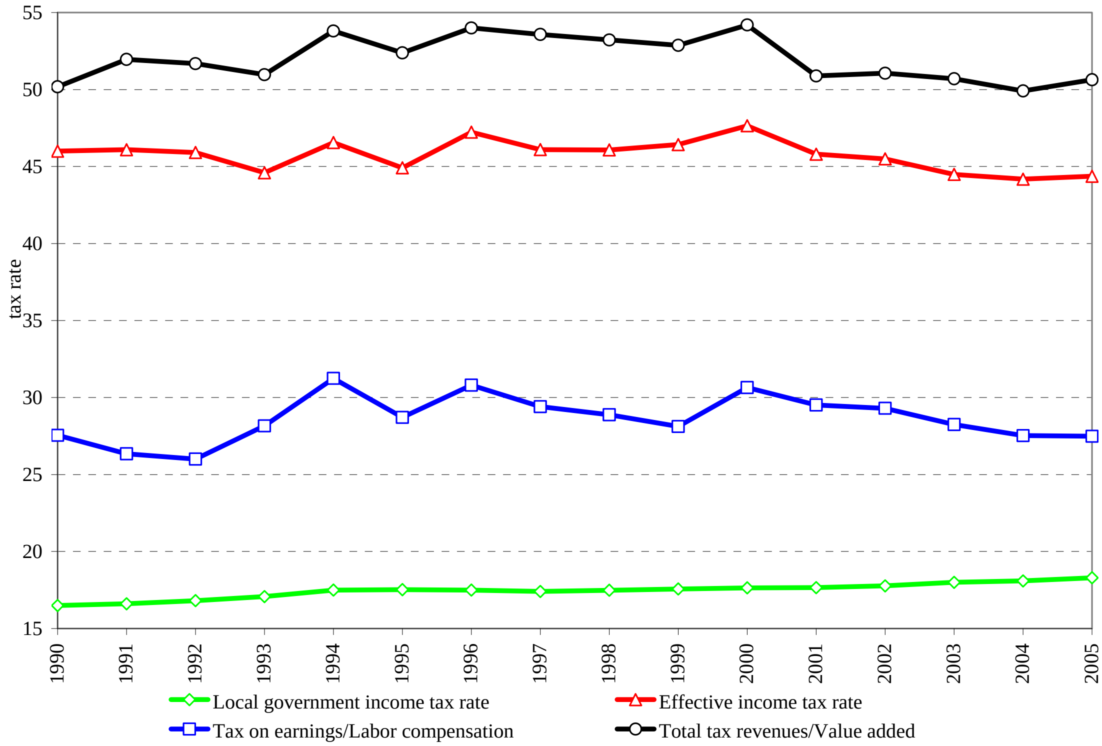
[32] Industrial workers.

Figure E1. Measure TFP in Finland, 1991-1997.



Notes: The figure plots TFP measured according to standard growth accounting applied to aggregate series in the data and impulse responses of aggregate series in the model. The method is described in Conesa et al (2007).

Figure E2. Tax burden.



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