Testing Russia's Virtual Economy

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Abstract

In the aftermath of sovereign default of August 1998, the hypothesis of virtual economy in Russia developed by Gaddy and Ickes has gained popularity. The hypothesis states that the country has not moved towards free-market economy but developed a system of implicit price subsidization similar to what had existed before. Non-viable sectors that the state supported with subsidies before survive by over-pricing their output. Customers pass the bill back to the government by reducing their tax liabilities.

We test the proposition that the distribution of the value-added across sectors is biased because of price distortions and estimate the distribution at world prices. The results support the claim that Russian price structure is different from the world level and three out of fifteen sectors, for which we construct price indices, become "value-destroying". We investigate the reasons behind price differentials and find that difference in processing and the use of barter explain a large part of it.

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Non-Technical Summary

In early 1998 Gaddy and Ickes suggested a new idea explaining why the Russian transition apparently failed.[2] Managers of economically bankrupt companies have preserved price distortions inherited from the Soviet time by exploiting political connections that they had developed during the time of command economy. They overcharged customers in barter transactions and created the pretense that the firms are economically viable. In their turn, the customers accepted "bad" deals because they have reduced nominal barter prices to market levels by employing offsets and accumulating arrears. The bill has been ultimately passed to the government through tax offsets. The latter is reluctant to expose the pretense because otherwise, it faces mass unemployment and subsequent political instability.

Following this logic, Gaddy and Ickes have inferred that the emphasis on preserving the nominal value of GDP in transition is wrong. If authorities press for settlement in money, the non-productive nature of many companies becomes obvious. Gaddy and Ickes have predicted that when it happens, the Russian economy contracts in the short run in absolute numbers but positions itself for the long-term growth by freeing resources that the value-destroying companies wasted before.

The default that happened in August 1998 seemingly justified their point of view. As the market exchange rate soared from 5,974 to 21,140 Rubles to the US Dollar, the dollar estimate of the Russian GDP fell from $ 414,897 million in 1997 to $ 127,548 million in 1998.[3] The notion that Russia had developed a peculiar form of "virtual economy" gained prominence.

The theory that Gaddy and Ickes proposed fitted nicely in the general perception of the Russian reform that emerged in the West following the default. It is hard to find publications of that time not peppered with accusations of bureaucratic corruption, theft of state assets, and pocketing of Western loans. This atmosphere affected policy-making with hardliners pushing for "tough love" with Russia and preaching that the country was a wreck and irrelevant anymore.

Yet, after gloomy predictions of impeding collapse in Russia failed to materialize, the voice of dissenters became heard. Joseph Stiglitz, the Chief Economist at the World Bank and a fierce critic of the policy of the Washington Consensus,[4] was the first to suggest that it might be we who are wrong and not they. He compared two transitions – Chinese and Russian – and asked the question of why the Chinese did opposite to what we advised and succeeded while the Russians followed the advice and failed? His answer was that assuming market institutions appear if government steps down is naive. Stiglitz did not question the importance of markets in itself but pondered on what form they might assume in transition. Judging by the Chinese experience, he decided that endogenously developed stakeholders' arrangements

[2] See Gaddy and Ickes [1998a and 1998b], Gaddy and Ickes [1999], and Ickes and Ericson [2000]

[3] At the end of December exchange rate at the Moscow International Currency Exchange, in non-denominated rubles. Data on GDP are from GKS [2000b] and on the exchange rate are from the Stockholm Institute of Transition Economics and East European Economies, "*Russian Economic Trends Database*", Stockholm 2000, available at http://www.hhs.se/site/ret/ret.htm.

[4] The Washington Consensus is a set of "sound" economic policies, which international and national economic organizations based in Washington agreed upon in the late 80-s. See John Williamson "What Washington Means by Policy Reform", in *Latin American Adjustment: How Much Has Happened?*, pp. 5-20, ed. John Williamson, Institute for International Economics, Washington, DC, April 1990, for details.

are superior to the Western-style shareholders' privatization plans in the absence of Western social norms.[5]

This clash of policy approaches has not generated quick empirical response. In part, empirical research has lagged behind because of data constraints but the instability of public opinion played a role as well. In the case of the virtual economy, as the initial interest in the hypothesis faded away, it was virtually forgotten. The only exchange of opinions with reference to facts, that the author is aware of, took place in October 1998 in the website publication *Johnson's Russia List*.[6] It did not lead to conclusive results, for arguments on both sides were based on anecdotal evidence. For example, the four-sector model of Gaddy and Ickes [1998b] introduces notation explicitly referring to Norilsk Nickel and Norilsk Gazprom. While both companies are large and important (Norilsk Nickel was the largest privately-owned company ranked by assets in 1997), their relationship is unrepresentative.[7] Opponents of the hypothesis seized the unfortunate case of gas-for-metal payment scheme to bring counter-examples of large foundries that used different arrangements. This focus on specific companies was unconvincing to both sides. However, as time passes, more evidence becomes available enabling us to contribute to the discussion on the role of barter and arrears in the Russian transition.

In this paper, we test the validity of the hypothesis of the virtual economy. The paper consists of four sections. Section 1 sketches the hypothesis and considers its predictions that we check afterwards. We do not expose the hypothesis in full because some parts are not addressed in the present investigation and other parts were not fully developed by its authors. It is sufficient for our purposes to concentrate attention on the key elements.

Section 2 explains how the statement that barter and arrears distort price signals and facilitate the survival of non-viable companies can be tested. We explore methodologies that are used in determining prices of goods produced by natural monopolies or imported from non-market economies. The literature on the measurement of value-added transferred resulting from tariff barriers is considered. A short discussion on data requirements concludes the section.

Section 3 is the core of the paper. It tests the proposition that Russian prices are not representative of actual values of the traded goods. We supplement domestic prices with prices attained in a market economy and find what the value-added for sectors would be in such circumstances. The result is that twelve out of fifteen sectors generate positive value-added. The sectors that become 'value-destroying' on price conversion belong to the low-processing segment of manufacture. This finding is at odds with the concept of the virtual economy that expects sectors with high degree of processing to be the least productive.

Section 4 introduces several reasons why Russian and world prices differ and checks their validity. We consider the degree of processing, the share of barter and change in trade arrears, effective import tariffs, and price inertia as the explanatory factors. The obtained results point out that the degree of processing and barter explain a large part of the difference. Russian

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[5] An interested reader is referred to Stiglitz, Joseph E. "Whither Reform? Ten Years of the Transition". Keynote address at the ABCDE, World Bank, Washington, DC, April 1999 (was available at http://www.worldbank.org/research/abcde/stiglitz.html). By the stakeholders' arrangement, we mean the organizational structure where powerful insiders own the firm while they are employed and have to abrogate their rights otherwise.

[6] See Johnson's Russia List (JRL) issues 2413, 2416, 2420, 2422, and 2424 for October 6-11, 1998 available at http://www.cdi.org/. JRL is an informal but influential forum that brings together scholars, journalists, government officers, and public working with Russian issues. The list is run by David Johnson accessible at davidjohnson@erols.com

[7] These two companies are in monopsony-monopoly relationship and all imperfections associated with such a market are present.

prices are found to be correlated with pre-transition levels and they are converging to the world level at the same time.

The paper concludes with several appendices. Appendix A presents statistical data on the share of barter and arrears in Russia. This topic is relevant to the discussion because non-monetary exchanges play a key role in the hypothesis and we say few words about it in Section 1. The other appendices provide technical details. We explain the methodology of how sectoral price ratios reported in Section 3 are found and present conversion tables for 232 sampled goods in Appendix B. Appendix C deals with the problem of tariff protection rates that are used to address the question of domestic-world price differentials raised in Section 3. Appendix D explains the methodology of calculating the index of processing that we use in Section 4.

1. The Relevance of Non-Monetary Exchanges to the Virtual Economy

When Gaddy and Ickes proposed the hypothesis of the virtual economy first, they observed bits and pieces of the economic environment that was complex and not described systematically. They detected unusual modes of trade and proposed an unorthodox explanation for this phenomenon.[1]

The essence of Gaddy and Ickes's story can be summarized in the following quotation: "At (the) heart (of the virtual economy) is the ultimate pretense that the Russian economy is larger than it really is. … It is the cause of the web of non-payments … from which Russia seemingly cannot emerge. … (T)his story … is a familiar one: The enterprises don't pay their suppliers; they don't pay their workers; they don't pay their taxes."[2] By non-payment Gaddy and Ickes mean that the agents engage in non-monetary exchanges.

We do not attempt to present all arguments and to explain the model that Gaddy and Ickes develop in detail.[3] There is sufficient literature, to which an interested reader is referred.[4] Besides, going into details tends to distract attention. The phenomenon of non-monetary exchanges in Russian transition offers a large number of competing explanations all of them suffering from small inconsistencies. To avoid being drawn into an open-ended discussion of why and how Russia developed trade without money, we focus our attention on two particular features. The first is the notion that prices for bartered and provided in credit goods and services were not of market origin and the second is the suggestion that processing sectors benefited from the non-monetary exchanges.

The hypothesis, that Gaddy and Ickes propose, introduces a two-sector economy producing primary and processed goods. For the sake of illustration let them be oil and machinery. Both goods serve as inputs in the production of one another. Government distorts the market by allowing firms to offset taxes with the delivery of machinery. The demand for machinery grows since taxpayers use them to minimize their tax obligations. The minimization works through barter schemes. If machinery is bartered for oil, it is optimal for both sides to inflate prices. Taxes are paid in nominal terms and, if the barter price for machinery is higher, it covers more of tax liabilities. Then, oil producers can exchange less of oil for machinery delivered later to the government than selling the same amount for money paid in taxes. Machinery producers are happy because they get relatively more oil in barter deals than when they pay in money.

If the government demands paying taxes in money, oil producers stop buying machinery for tax purposes. The reason for barter exchanges disappears and relative prices change. This new situation changes the structure of costs and revenue and machinery producers find that the cost of oil that they use in production exceeds the value of machines.

This logic suggests the structure of our first test. If we know the structure of costs and revenue and if we are able to obtain estimates of market prices with no distortions, we can check the

[1] In general, it is not obvious that barter and arrears are of non-market nature, for both modes are legitimate in market economies. Apparently, the degree of non-monetary exchanges struck observers as unusual.
[2] See Gaddy and Ickes [1998c]
[3] Apparently, the model continues to be refined: As recently as November 7, 2001 Gaddy was introduced as a co-author of a forthcoming book *Russia's Virtual Economy*. During the briefing he confirmed that the idea of virtual economy is very much alive (see Brookings Briefing "President Putin Comes to America: Is An Old Adversary Becoming a New Partner?" at www.brookings.edu).
[4] Gaddy and Ickes [1998a, 1998b, 1998c, 1999]

proposition that the barter hides the inter-sectoral transfer of value. The first problem that we encounter is to find "good" prices that we assume are unobservable at the actual market place according to the hypothesis of virtual economy.

2. Prices in the Absence of Markets: Methodological Issues

Economists have devised several methods to derive shadow prices for non-marketable goods. Pricing the output of natural monopolies is one example. By definition, a natural monopoly market is distorted in the sense that the allocation of resources is inefficient.

Responding to economic inefficiency that monopolistic pricing introduces, the government corrects the situation by setting a price range.[5] The problem that the government faces is apparently similar to what we have: "good" prices are unobservable and are to be inferred.

The general solution to the problem of monopolistic pricing is to calculate the average cost of production for a number of companies,[6] add a markup, and come to the unit price. This method is unsuited for our purposes. Essentially, it is based on the assumption that, while output prices are distorted, the input prices are not. We cannot make this assumption because the hypothesis of virtual economy conjectures that the values of both outputs and inputs are set outside of the market.

The second method originates in the international trade practice. The General Agreement on Trade and Tariffs (GATT) acknowledges the possibility of "dumping" and legitimizes the use of countervailing duties in trade conflicts.[7] By definition, dumping involves non-market pricing. To bring the announced price back to its market level, the trade authority of a country affected levies a duty that covers the difference.

The situation of dumping corresponds to what Gaddy and Ickes allege Russia faced in 1997 in reverse: announced prices were higher than what would be efficient. This similarity of situations suggests that we are able to use international trade practices to construct a methodology of finding market values for Russian goods. Unfortunately, this approach applies to tradable goods only.

Let us consider in detail how the value of countervailing duties is calculated in practice. The trade authority can use the same cost pricing approach as in the case of natural monopoly. It takes the average price at which the imported good is sold domestically in the exporting country, and finds the difference between exported and domestic price determining the duty. Again, this method is based on the assumption that domestic prices are efficient, which contradicts to the setting of the hypothesis we consider.

If an imported good is deemed to be valued outside of the market of the exporting country, its price structure is totally discounted and replaced with the prices determined in an "analogue

[5] In limit, the range collapses to a single price.

[6] For example, we can use averaged cost structure for a group of utility providers of adjacent provinces or states.

[7] See GATT [1986, Article VI].

country". This approach uses the same assumptions as we do and is taken as the basis for our methodology.[8] The problem of the analogue country comes next.

The concept of the analogue country is not well specified in trade documents and the World Trade Organization does not mention it on its website. The European Union is explicit about the concept.[9] Article 2(7) of the Council Regulation (EC) No 384/96 of 22 December 1995 states that "In the case of imports from non-market economy countries … normal value shall be determined on the basis of the price … in a market economy third country". The EU fails to set explicit criteria for determining how the analogue country is to be selected noting only that the analogue country "shall be selected in a not unreasonable manner, due account being taken of any reliable information made available at the time of selection".[10] Further examination of legal documents related to countervailing duties imposed by the EU has shown that it uses the following criteria selecting the analogue country: [11]

- a country has been used previously in a similar investigation
- a country cooperates in the investigation
- it has several producers leading to strong domestic competition
- the price of the product in this country is similar to that in the EU and the costs of inputs is similar to the cost structure of the exporting country

Taken together, these requirements impose severe limits on the list of potential candidates and the effort by the EU to make the full use of the clause on "not unreasonable choice" is perfectly understandable.[12]

We propose to use the US as the analogue country. This country produces a wide variety of goods and is similar in geographic size and the wealth of natural resources to Russia. This country is often taken for two-country comparative studies. The US economic data is readily available. Finally, America is believed to have the freest market in the world and its prices arguably reflect the most efficient allocation of resources, the condition that we attempt to find.[13]

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[8] In addition, Russia is explicitly considered to have a non-market economy in several trade disputes. See the Council Regulation (EC) No 519/94 of 7 March 1994 on common rules for imports from certain third countries (available at http://www.iue.it/LAW/globalisation/documenti/ecreg_519_94.htm).

[9] The author has been advised that the US Trade Commission used a similar approach in 1980s.

[10] See the Council Regulation (EC) No 384/96 of 22 December 1995 on protection against dumped imports from countries not members of the European Community (available at http://www.iue.it/LAW/globalisation/documenti/ecreg_384_96.htm).

[11] The EU website (http://europa.eu.int/eur-lex/en/lif/reg/en_register_11604020.html) lists the directory of Community anti-dumping rulings. It contains around 100 regulations, out of which ten relates to Russia. We have used Council Regulation (EC) No 1100/2000 of 22 May 2000 and No 1995/2000 to compile a list of requirements regarding the choice of the analogue country.

[12] For example, in the anti-dumping case referring to the import of urea from Russia, the EU committee recommended to use the cost structure provided by the only producer in Slovakia as the benchmark against which the costs of Russian urea manufacturers were recalculated. The proposal of EU importers to use Canadian data on the ground that Slovakia does not extract gas (a major component in urea production) was rejected because Canada did not answer on the lengthy questionnaire sent during the hearings. Brazil appears the most often as a candidate but the author has not been able to find consistent data from this country.

[13] If geographic proximity would be the most definite factor, Germany is a better candidate. The author has been advised that German data are well detailed for comparative purposes than American's but America appears to be

The experiment that we conduct in this paper differs from regular trade practice of assessing the countervailing duty in one important aspect. Unlike considering a single product, against which a complaint is lodged, efficient prices for a wide array of products are to be found while accounting for secondary effects introduced by technological constraints. The latter is introduced through the use of input-output table.

In this study, we face serious data limitations. The Russian State Committee for Statistics (GKS) does not publish much data and what is published is distributed through its commercial branch that limits further access. There are available broadly aggregated input-output tables for 1995-7. It is overly restrictive because only ten sectors are present and the main important sectors of mining and manufacture are merged.[14]

To come around data constraints, we choose the following strategy. We take the Russian input-output table for 1997 based on GKS [2000b, Table 4.3] and construct a more detailed table using RAS approach.[15] The entries of the table are converted its entries into US dollars using sectoral price ratios introduced in the next section. The resulting cost-revenue structure shows what would happen with the Russian economy if it momentarily switches to the US prices. Assuming that the US prices are efficient, this experiment provides a numerical evaluation of the claim that Russian domestic prices hide the value-destroying nature of manufacturing sectors.

Our methodology of finding the transfer of value across sectors using shadow prices is similar to the approach pioneered in Corden [1966]. Corden asks the question of what is the value of protection that industry *j* receives because of import tariffs on both good *j* and material inputs used in its production. He determines the unit value transferred as

$$\Delta Value_j = Price_j \times (Tariff_j - \sum_i Tariff_i \times Coefficient_{ij}) \qquad [1]$$

where $Coefficient_{ij}$ is the share of input *i* in the cost structure of *j*. In our case the unit value transferred can be found as

$$\Delta Value_j = (Price_j^{US} - Price_j^{Rus}) - \sum_i (Price_i^{US} - Price_i^{Rus}) \times Coefficient_{ij} \qquad [2]$$

where $Price_j^{US}$ is the US price of good *j* in rubles. The latter term is introduced for illustrative purposes and is replaced with the individual price ratio introduced in the next section in actual calculations.[16]

3. The Assessment of Virtual Economy: Shadow Price's Approach

In this section we test the proposition that if Russian economy uses shadow prices, we observe some sectors become value destroying. Formally, the test consists of two steps. First, shadow

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more suited in other respects. In addition, the linguistic barrier makes German-Russian comparison a more challenging exercise for the author.

[14] The Department of Agricultural Economics at the Purdue University has constructed a worldwide input-output table containing 57 sectors (GTAP table). It contains estimates of elasticities and is used for trade modeling exercises. The table has the sub-table for the Commonwealth of Independent States that could serve as an approximation of Russian economy. We do not consider this table in our research because we believe it is less consistent with other Russian sources than the table reported by the GKS.

[15] See Appendix B for technicalities.

[16] The author is thankful to J. Clark Leith of the University of Western Ontario for pointing on the similarity of approaches.

prices are found by using price ratios for economic sectors constructed below and, second, the ratios are used to recalculate sectoral revenues and costs.

We collect a sample of individual prices for the same goods and the same time period in both Russia and the USA assuming, initially, that goods do not differ in quality. Table B2 contains the list of 232 goods that we use in our investigation (see Appendix B). The individual price ratio of good *j* is found as

$$IndividualPriceRatio_j = \frac{Price_j^{Rus}}{Price_j^{US} \times Factor_j} \qquad [3]$$

where $Factor_j$ is the conversion factor that is the ratio of the unit of measurement in Russia to the American unit of good *j*.[17]

Because we are interested in the sectoral price ratios, we have to choose a method of aggregation. It is standard in the literature to take the value of product as its weight. We have two estimates of values that can be taken individually or as a group: the values of Russian products measured at Russian and American prices. However, we have explicitly introduced the assumption that observed Russian prices are not market determined, which makes the proposition to use them as the weights to be inconsistent with the rest of the paper. Therefore, we calculate the weight of good *j* using the US prices applied to Russian physical output

$$Weight_j = \frac{Price_j^{US} \times Factor_j \times Output_j^{Rus}}{\sum_{j \in I} Price_j^{US} \times Factor_j \times Output_j^{Rus}} \qquad [4]$$

where *I* is the set of goods belonging to the same sector.

Weighted individual rates are aggregated into sectoral price ratios following the *All-Russian Product Classification OK-005-93* and *All-Union Industrial Classification of National Economy OKONKh-1-75-018*.[18] The formula for finding the price ratio for sector *I* is

$$PriceRatio_I = \sum_{j \in I} IndividualPriceRatio_j \times Weight_j \qquad [5]$$

[17] For example, one Russian ton contains 7.46 US barrels of crude oil in our calculations. The references to the unit conversion sources are at the bottom of Table B2.

[18] Classifications are issued by Russian State Committee for Standards on December 30, 1993 (a version is available at http://www.energomash.ru/OKP) and by All-Soviet State Committee for Standards on January 1, 1975 (available at http://www.standard.ru/classif/okonh/okonh.phtml).

Table 1: The value of intermediate costs, output, and value-added in absolute values

		Input-output table 1997 (in billion of rubles)		I/O '97 converted at price ratios (in million of US dollars)		
		Costs	Output	Costs	Output	Value-added at producer's price
1	Electricity	94,620	205,938	66,991	63,630	**-3,361**
2	Oil extraction	22,304	94,649	7,559	34,234	26,675
3	Oil processing	84,907	142,427	31,154	31,732	577
4	Gas extraction	20,447	60,483	9,461	126,588	117,127
5	Coal and other fuels mining	19,120	41,751	7,485	20,820	13,335
6	Iron and steel	90,701	121,366	33,938	29,576	**-4,362**
7	Non-ferrous metallurgy	45,673	91,429	15,231	23,196	7,965
8	Chemical and petrochemical	85,453	117,349	30,331	21,859	**-8,472**
9	Machine building and metal processing	163,308	291,945	61,701	132,096	70,395
10	Wood and paper	39,869	61,810	13,187	21,502	8,315
11	Construction materials	41,136	71,622	16,425	27,723	11,298
12	Textile, apparel, and footwear	18,658	31,604	6,483	10,907	4,424
13	Food processing	178,467	252,755	60,858	101,160	40,302
14	Other manufacturing	22,194	41,320	9,279	52,049	42,770
15	*Construction*	162,906	348,730	61,708	146,289	84,580
16	Agriculture and forestry	170,718	322,565	61,618	73,010	11,392
17	*Transportation*	120,877	363,137	44,444	152,332	107,888
18	*Communications*	17,214	62,685	6,526	26,296	19,770
19	*Trade, intermediation, and food services*	171,241	671,025	66,868	281,488	214,620
20	*Other activities related to goods and services*	9,373	29,203	5,196	12,250	7,054
21	*Residential, communal, and household services*	101,462	241,575	41,288	101,338	60,051
22	*Health, education, and culture*	134,302	333,869	52,172	140,055	87,883
23	*Science, geology, and meteorology*	34,229	65,511	13,518	27,481	13,963
24	*Finance, credit, and insurance*	21,610	39,996	9,085	16,778	7,693
25	*State and business management and NGO*	156,029	327,542	67,184	137,400	70,216
	Memo: Total	2,026,706	4,432,287	799,690	1,811,788	1,012,098

Sources: Data reported are from the input-output table for 1997 (see GKS [2000a], adjusted as explained in Appendix B); other columns are author's calculation. Sectors in italics are converted at the ratio of Russian GDP in rubles to its estimate at the PPP exchange rates.

Price ratios are constructed for 15 sectors only. The prices for other sectors are converted at the price ratio of Russian GDP expressed in rubles to the estimate of GDP calculated by the World Bank at the PPP exchange rate.[19]

[19] Russian GDP stands at 2,523,542.3 billions of rubles by the GKS estimate (see GKS [2000b, Table 2.13]) and at 1,058.6 billions of US dollars by the World Bank estimate (see the 2001 World Development Indicators CD-ROM Win*STARS, Version 4.2, Series "GDP, PPP (current international $)"). This amounts to 2383.85 Ruble/US $.

In principle, it is possible to compare the value of services provided by the sectors of transportation, communications, and trade (see Ark and Timmer [2001]). However, such an exercise is not easy to defend methodologically. The use of prices originating in an analogue country rests on the implicit assumption that goods in both countries are substitutes. Services are not tradable by definition. Even if we have enough data to compare prices per ton-km of transportation, Russian consumers will not be able to receive American services at that price. The direct comparison of prices in sectors related to the provision of public services is impossible because the unit of measurement is absent.

Table 1 presents the comparison of ruble and recalculated dollar values of sectoral revenue and total material costs in absolute values. The sum of recalculated value-added ($ 1,012 billion) comes close to the value-added estimated by the World Bank ($ 1,059 billion), which suggests that our procedure of finding sectoral price ratios is compatible with similar calculations.

The estimates of value-added at shadow prices show that there is significant transfer of value across the sectors. This finding indicates that Gaddy and Ickes might have found a distortion to be corrected. However, before we proceed with policy suggestions, let us consider what this finding implies. The sectors that are found generating negative value are electricity, iron and steel, and chemical and petrochemical manufacturing. These sectors are usually viewed as industries producing low-processing goods. It means that, along with mining, producers of high-processed goods benefit if Russian prices converge to the world level, which is opposite to what Gaddy and Ickes expect. Another implication of the hypothesis appears to be dubious as well. According to Gaddy and Ickes if the "value-destroying" sectors go bankrupt, the economy will improve in the long run. They mean, apparently, that the output of the sectors can be replaced with import. In fact, the import of electricity accounts for less than one percent of total consumption and the share is unlikely to grow. The sector of iron and steel is a major exporting and not importing sector. The only sector whose products are imported significantly is chemical manufacturing but it is a large exporter as well. In total, it seems implausible that importing helps if bankruptcy is what envisioned for the sectors. Finally, our estimate of "new" GDP is lower than that calculated by the World Bank. Thus, the conjecture that GDP will grow at new prices does not hold the ground.

To take a closer look on the changes that have occurred after the price conversion, we have constructed Table 2. It shows the weighted ratios of revenue, costs, and value-added found as

$$Ratio_i = \frac{Value_i^{Rus} \times WBPriceRatio}{Value_i^{US}} \qquad [6]$$

where *Value* stands for either revenue or costs for sector *i* and superscripts *Rus* and *US* mean its ruble and recalculated dollar value. *WBPriceRatio* is the ratio of GDP in rubles to the GDP estimate calculated by the World Bank at the PPP exchange rate.

Table 2 divides sectors into two groups according to whether their ratio of value-added is below or above half of the ratio for total economy. The first part comprises metallurgy, agriculture, and sectors that are heavily dependent on fuels: electricity, oil processing, and chemicals. Three of these sectors generate negative value-added and are "virtual" in the Gaddy and Ickes's sense. The rest come close. A casual look at their cost structure indicates that costs at shadow prices grow mostly due to the increase in prices of fuels (oil, gas, and coal) for all sectors apart from agriculture.[20]

Let us take a closer look at three sectors, which generate negative value-added at the shadow prices. The change in the share of input cost is reported in Table 3. It is found as

$$ShareChange_i = \frac{Cost_i^{Con}}{Revenue_i^{Con}} - \frac{Cost_i^{Nom}}{Revenue_i^{Nom}} \qquad [7]$$

[20] The latter is apparently supported with price floors.

where superscripts *Con* denotes the revenue or total cost of input *i* converted at the price ratio and *Nom* stands for the value determined at nominal (observable) prices.

Table 2: Relative values for sectors, for which sectoral price ratios are calculated; sorted by the magnitude of the ratio of the value-added; found using equation [6]

		Ratio of intermediate costs	Ratio of revenues	Ratio of value-added
1	Chemical and petrochemical	0.85	0.44	**-0.63**
2	Iron and steel	0.89	0.58	**-0.34**
3	Electricity	1.69	0.74	**-0.07**
4	Oil processing	0.87	0.53	0.02
5	Agriculture and forestry	0.86	0.54	0.18
6	Non-ferrous metallurgy	0.79	0.60	0.41
7	Textile, apparel, and footwear	0.83	0.82	0.81
8	Oil extraction	0.81	0.86	0.88
9	Construction materials	0.95	0.92	0.88
10	Wood and paper	0.79	0.83	0.90
11	Food processing	0.81	0.95	1.29
12	Machine building and metal processing	0.90	1.08	1.30
13	Coal and other fuels mining	0.93	1.19	1.40
14	Other manufacturing	1.00	3.00	5.33
15	Gas extraction	1.10	4.99	6.97
	Total economy	0.94	0.97	1.00

Sources: Table 1 of this paper.

We see that the change in the cost of fuels coupled with changes in transport and trade margins are responsible for dropping value-added of the sectors to the negative territory. This structure of changes in the value of material cost is consistent with the observation made by Gaddy and Ickes: "three fat men" of Russian economy[21] support other sectors with relatively low prices on their products. The reference of Gazprom helping to the sector of iron and steel that we have mentioned before appears to be reasonable as well.

While the importance of fuel costs is to be expected given our previous discussion, significance of transport and trade margins is more troubling. Recall that we do not calculate shadow prices for the sectors of transportation and trade but base their supposed "market" values on the World Bank estimate of Russian GDP at the PPP exchange rate. If the shadow prices for sectors with non-tradable services are evaluated at the official exchange rate instead, chemical manufacturing remains the only sector with the negative value-added on conversion. Therefore, the significance of transport and trade on conversion depends critically on the assumption about the relative productivity of these sectors that we make.

Up to now we have proceeded on the assumption that the US prices are representative of the market value of Russian goods. In fact, it might not be the case. Usually, Russian goods are considered to be of inferior quality compared with its Western counterparts. We want to explore if adjusting for quality change the results obtained so far.

[21] They are natural gas monopoly Gazprom, the Ministry of Railroads, and the United Electric System that controls the national power grid.

Table 3: The changes in material input cost shares for the sectors with the negative value-added recalculated

		Electricity	Iron and steel	Chemical and petrochemical	Simple average cost change
1	Gas extraction	0.474	0.099	0.216	0.263
2	Transportation	0.050	0.080	0.096	0.075
3	Electricity	0.000	0.030	0.136	0.055
4	Trade, intermediation, and food services	0.024	0.046	0.058	0.043
5	Coal and other fuels mining	0.031	0.088	0.008	0.042
6	Machine building and metal processing	0.011	0.028	0.037	0.026
7	Other manufacturing	0.008	0.012	0.029	0.016
8	Science, geology, and meteorology	0.000	0.006	0.017	0.008
9	Other activities related to goods and services	0.001	0.005	0.006	0.004
10	Wood and paper	0.000	0.001	0.010	0.004
11	Construction	0.001	0.004	0.006	0.004
12	Communications	0.000	0.002	0.006	0.003
13	Construction materials	0.000	0.001	0.005	0.002
14	Iron and steel	-0.001	-0.001	0.008	0.002
15	Oil extraction	0.000	0.000	0.006	0.002
16	Food processing	0.000	0.000	0.004	0.002
17	Finance, credit, and insurance	0.001	0.001	0.002	0.001
18	Residential, communal, and household services	0.000	0.001	0.002	0.001
19	State and business management and NGO	0.000	0.001	0.001	0.001
20	Non-ferrous metallurgy	0.000	0.000	0.001	0.000
21	Health, education, and culture	0.000	0.000	0.000	0.000
22	Textile, apparel, and footwear	0.000	0.000	0.000	0.000
23	Agriculture and forestry	0.000	0.000	0.000	0.000
24	Oil processing	-0.007	-0.001	0.005	-0.001
25	Chemical and petrochemical	-0.002	-0.002	-0.001	-0.002
	The change in material costs to revenue ratios	0.593	0.400	0.659	0.551

Sources: Author's calculations

It is not clear from economic literature how to measure quality. One suggestion is to compare domestic prices for Russian and imported goods with similar functional properties. The difference in prices, if any, provides a quantitative estimate of quality on the basis of revealed preferences. Unfortunately, this approach is infeasible due to data constraints.

We propose a different method. Assuming that capital and labor is less productive in Russia, the degree of processing for sectors can serve as a weighting coefficient that introduces quality in the evaluation of shadow prices for domestic goods. The next step is to determine the methodology for finding the degree of processing.

First, the sectors are divided in primary and processing. Essentially, we list primary goods and find the share of its value in total revenue using data on the composition of sectoral output (see Appendix D for details). The primary good is defined to be a good naturally available such as minerals, raw fuels, and unprocessed lumber plus raw agricultural products and electricity.

Next, we calculate the index of processing, which is the processing value accrued to the unit value of primary inputs. While the actual formula that finds the index includes values of intermediate input (see formula [D1] of Appendix D), it becomes the ratio of the costs of primary goods to the total revenue if intermediate inputs are ignored

$$IndexProcessing = \frac{\sum PrimaryCost_k}{Revenue} \qquad [8]$$

Appendix D contains calculations and the estimates of the indices of processing.

The indices found cannot be used in determining shadow prices like we have done before. They are calculated on the assumption that processing is 'virtual', in the sense that it does not add any value to the final product.[22] Thus, the impact that the introduction of estimated quality would have on the value-added generated by sectors is to be assessed differently.

We consider the proposition that domestic prices come closer to shadow prices if adjusted for quality is a natural supplement to the hypothesis of virtual economy. If quality is the parameter that biases our results, its inclusion should reduce the gap. Then, the variance for the sample of ratios adjusted is to be smaller than for the same sample involving unadjusted ratios. The results are reported in Table 4. The variance is calculated around the mean normalized to unity.[23]

Table 4: Price ratios unadjusted and adjusted by the degree of processing

	Sector	Unadjusted Price Ratio	Adjusted Price Ratio
1	Electricity	3,237	3,237
2	Oil extraction	2,765	2,765
3	Oil processing	4,488	2,622
4	Gas extraction	478	478
5	Coal and other fuels mining	2,005	2,005
6	Iron and steel	4,103	2,697
7	Non-ferrous metallurgy	3,942	2,369
8	Chemical and petrochemical industry	5,368	3,255
9	Machine building and metal processing	2,210	805
10	Wood and paper	2,875	1,586
11	Construction materials	2,583	1,207
12	Textile, apparel, and footwear	2,898	1,432
13	Food processing	2,499	1,483
14	Other industries	794	326
15	Agriculture and forestry	4,418	4,418
	Variance (around the mean normalized to unity)	0.204	0.315

Sources: Column 1 is from Table 1, column 2 is the product of column 1 of this table and column 2 of Table D1.

The result reported in Table 4 does not show that the adjustment for quality reduces the variance of price ratios. Thus, we cannot state that quality, approximated by the degree of processing in this case, is an important factor that biases our results.

4. Explaining Price Differentials

The results obtained lead to the question of why price ratios differ so remarkably across the sectors. There are several potentially valid hypotheses to be explored.

Suppose the processing is less productive in Russia, in the sense that the same level of processing results in the production of goods of lower quality. Then, the ratio of domestic to American prices should fall as the degree of processing increases.

[22] The latter carries forward the value of primary goods spent in the production.
[23] Technically, we divide the variance by the average price ratio in second power.

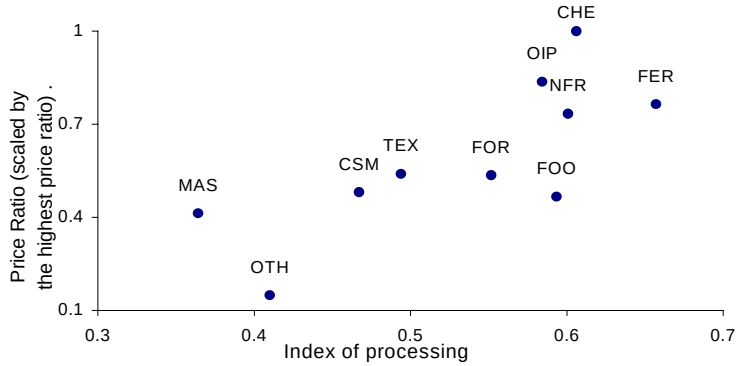
The same result is obtained if the cost of factors of production relative to the cost of inputs is lower in Russia. Then, the more processing is involved, the less is the relative price of domestically produced goods given that markets are competitive.

We use the index of processing introduced in the previous chapter and regress it on the price ratios. Figure 1 presents a scatter diagram of the index of processing and price ratio. It shows that the parameters are positively correlated. Statistical analysis supports this claim. The OLS regression finds that

$$PriceRatioNormalized = -0.410 + 1.848 \times IndexProcessing \qquad [9]$$

with t-statistics for β being 3.02, which is significant at the 98 percent level. The correlation coefficient is 0.753.

Figure 1: Scatter diagram of the index of processing (Table D1) and price ratio (rubles per dollar scaled, Table B3, general consumption) for 10 processing sectors.



Let us consider what the detected correlation implies. The index of processing represents, in its simple form, the ratio of unit cost of primary inputs to the value of processed output. The other variable represents the ratio of Russian to American values of the processed goods. As the index of processing falls, which corresponds to a higher level of processing, Russian goods become relatively cheaper compared to their US counterparts.

Since we do not discriminate between the difference in quality (as we have assumed before) and the relative cost of factors of production, it is unclear what of two reasons is the most important. Yet, in both cases domestic prices convey information on the market evaluation of goods, which contradicts the proposition that they are 'virtual'.[24]

Another explanation of the price differentials is that Russian prices, unlike its American counterparts, include additional charges such as interest on overdue trade credit or transaction costs associated with barter.

The late payment is expected to rise as the flow of receivables that firms accumulate increases.[25] The scatter diagram of the share of the change in receivables to total trade and price ratios is presented on Figure 2. It shows that the parameters are weakly negatively correlated. The OLS regression finds that

[24] The correlation between the index of processing and price ratio is not very robust. The author has attempted to add agriculture and electricity to processing sectors because they do not fit the definition of primary industries provided above and t-statistics has dropped below the 95% significance level.
[25] We choose the flow over stock of receivables as being closer related to the time frame that we cover.

$$PriceRatioNormalized = 0.615 - 0.012 \times ChangeReceivables \quad [10]$$

with t-statistics for β being –0.94, which is significant at the 63 percent level. The correlation coefficient is -0.251.

Figure 2: Scatter diagram of the changes in receivables (in percent to revenue, Table A5) and price ratios (rubles per dollar scaled, Table B3, general consumption) for 15 sectors.

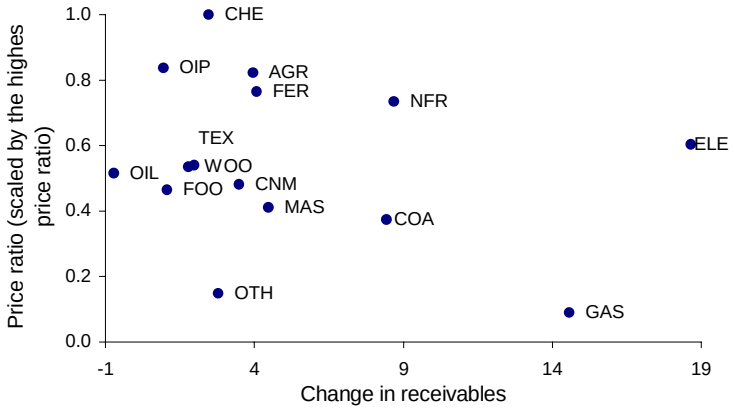


Figure 3 depicts the relationship between the shares of barter in trade and price ratios. The parameters appear to be weakly positively correlated. The OLS regression finds that

$$PriceRatioNormalized = 0.222 + 0.006 \times BarterShare \quad [11]$$

with t-statistics for β being 1.32, which is significant at the 79 percent level. The correlation coefficient is 0.343.

Both single regressions do not find that the difference in trade practices is an important explanation of price differentials. This result suggests that the emphasis of peculiar trade arrangements as the main price distortions is misplaced.

Next, we consider whether the difference in prices detected can be attributed to import barriers.[26] To determine the relative sizes of tariff regulations, we take import tariff rates effective in 1997 and find sectoral rates using the same aggregation procedure as used in the construction of price ratios. We consider that domestic price regulation amounts to trade barrier on export and add the difference between domestic and export price to tariff rates for affected sectors.[27] The general formula that finds the rate of price protection for product *j* is

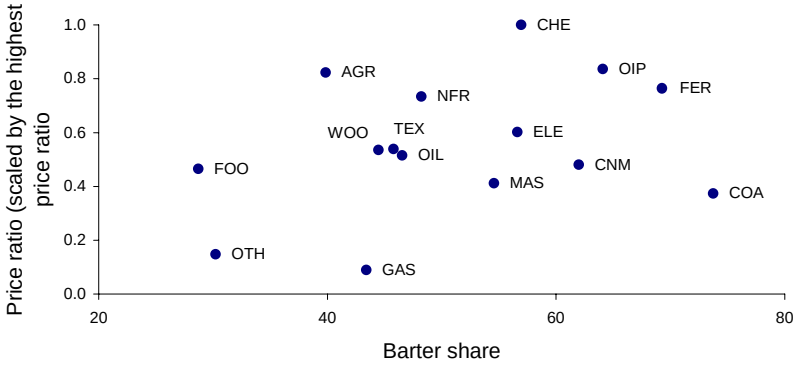
[26] We exclude the issue of export barriers because it requires constructing tariff structures for main Russian trade partners, which is complicated and, in general, irrelevant to the allegation of inflated values of output that we explore.

[27] The last consideration affects the sector of natural gas extraction only. While the domestic price for electricity is similarly controlled, it is higher than uncontrolled export price. This fact suggests that it is price floor that is set domestically and not price ceiling. Since export and import prices are practically identical ($ 24.26 and $ 24.31 per 1,000 kW-H), we consider that electricity sector is tariff-protected.

$$Rate_j = \begin{cases} 0, & if\ Price_j^{Rus} - Price_j^{US} \times Factor_j \times Exchange_{Rus/US97} \le 0 \\ Min\left[\dfrac{Price_j^{Rus}}{Price_j^{US} \times Factor_j \times Exchange_{Rus/US97}} - 1, Tariff_j \right], & otherwise \end{cases} \quad [12]$$

where $Exchange_{Rus/US97}$ is the market exchange rate for 1997. Appendix C explains the procedure for calculating rates and contains the table of its estimates.

Figure 3: Scatter diagram of the barter share (in percent to total revenue, Table A6) and price ratios (rubles per dollar scaled, Table B3, general consumption) for 15 sectors.



We expect that if import barriers explain price differences between domestic and world market prices, they should be positively correlated with price ratios. The scatter diagram of tariff protection rates and price ratios is shown on Figure 4. It indicates that a slight positive correlation is present. The regression shows that

$$PriceRatioNormalized = 0.572 + 0.012 \times ProtectionRates \quad [13]$$

with t-statistics for β being 2.38, which is significant at the 96 percent level. The correlation coefficient is 0.552.

This result is to be expected. According to the theory, in the perfect world the price arbitrage is eventually dissipated as traders take the opportunity to earn extra profit. The only difference in prices remaining is the value of trade barriers. Both the sign and the significance of our result are congruent with the theory.[28]

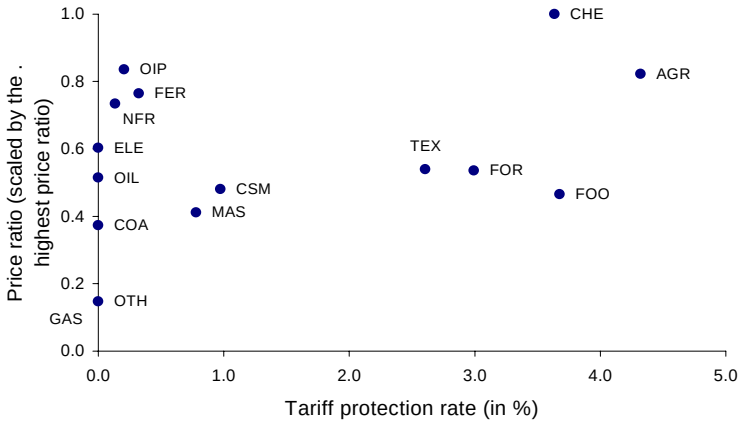
Single variable regression analysis shows that modes of trade are not significantly correlated with the price ratios. Let us check that multivariate regression yields a similar result. We regress all four parameters of interest on the price ratio getting

$$PriceRatioNormalized = -0.784 + 0.010 \times BarterShare + 0.016 \times ChangeReceivables + \\ + 1.347 \times IndexProcessing + 0.052 \times ProtectionRates \quad [14]$$

with t-statistics for coefficients being 2.81, 0.68, 2.57, and 1.37 respectively.

[28] However, the significance depends critically on the sector of gas extraction, which is an outlier. Without this sector, the level of significance drops to 1.291.

Figure 4: Scatter diagram of the protection rates (in percent to total revenue, Table C1) and price ratios (rubles per dollar scaled, Table B3, general consumption) for 15 sectors



Since the change in receivables and protection rates do not appear to explain price differentials, we reduce the number of parameters and run a bivariate regression

$$PriceRatioNormalized = -0.7 + 0.008 \times BarterShare + 1.628 \times IndexProcessing \qquad [15]$$

T-statistics for coefficients improves to 2.53 and 3.42, which is significant on the 95 percent level. Adjusted R-square is 0.715 for the exercise.

We conclude that both the use of barter and the difference in processing explain much of the detected price variation. These factors make opposite impacts: while the use of barter rises Russian prices relative to the US level, more processing lowers them. The growth in trade arrears and protection tariffs appear to have insignificant impact on prices. The first finding implies that traders do not systematically account for possible delay in payments. The second suggests that a statistically significant relationship between import fees and price differentials that we have found in [13] is not robust, the fact that we have already mentioned in footnote [35].

Finally, we consider if individual Russian prices possess inertia remained from the Soviet time. This exercise addresses the conjecture that Russia has simulated market reforms preserving, in fact, a command economy with state-regulated prices.

Defining inertia is not a straightforward exercise. We have to determine an initial position, target, and the speed of approaching the target. Let Russian pre-transition prices of 1991 be the beginning and the US prices of 1997 – the target, while the position that Russian prices had in 1997 be measuring the speed of approaching the target if any progress is present.

Since prices are measured in different units (pre- and mid-transition rubles and dollars), it is necessary to bring them to the same denominator. We propose to use the price of some basic product as the numeraire. Since the prices of electricity and gas were controlled in Russian transition, the price of one metric ton of oil is chosen.

Russian prices for 1991 are recalculated from average prices for December 1991 and price indices available for a sequence of years 1992-7 for 140 goods out of 232 present in the sample. We use data from GKS [1998d, tables 2.18, 2.20, 4.6, 6.8]. The regression of Russian prices of 1991 and US prices of 1997 on Russian prices of 1997 yields the following result

$$RusPrice97 = -0.418 + 0.356 \times RusPrice91 + 0.056 \times USPrice97 \quad [16]$$

with t-statistics being 13.39 and 5.97 respectively. Both parameters are significant at the 99 percent level.

The correlation detected is hardly surprising because the sample includes relatively cheap and expensive products that preserve their ranking in time and across the border. The important thing is that both parameters explain a portion of the Russian prices of 1997 in our sample and not contradict one another. The single regressions find that the Russian prices of 1991 serve as a better explanation than the US prices of 1997. While together they are able to explain 0.877 of the variance, the first explains 0.845 and the second – 0.716. Therefore, price inertia appears to be significant. Still, the impact of the world prices cannot be rejected on the basis of found evidence.

Conclusion

In this paper we have extended the discussion on the nature of transitional Russian price structure to the field of empirical research. The previous discourse has generated a large number of propositions that have not been tested in a systematic manner.

We have taken the hypothesis of virtual economy as our starting point and checked the proposition that Russian domestic prices have been deliberately distorted to conceal the value-destroying nature of economically non-viable but politically important sectors. We have recalculated the value-added for economic sectors using the method of shadow pricing and found that three out of fifteen sectors correspond to the definition of value destruction in the sense that at shadow prices the cost of material inputs exceeds the value of its output. Moreover, the analysis of their shadow cost structure indicates that the main cost increases are associated with the inputs supplied by state-controlled monopolies. This finding is consistent with the proposition that politics is involved in price setting in Russian transition.

The sectors that are found generating negative value are electricity, iron and steel, and chemical and petrochemical manufacturing. These sectors are usually viewed as industries producing low-processing goods. Other sectors, including producers of high-processed goods, benefit if Russian prices converge to the world level. This finding is opposite to what Gaddy and Ickes suggest: prices are distorted to support sectors at the high-processing end.

The implication of the hypothesis that if the “value-destroying” sectors go bankrupt the economy will improve in the long run appears to be dubious. First, it means, apparently, that the output of the outgoing sectors can be replaced with import. In fact, the import of electricity is miniscule and its share is unlikely to grow on technical grounds. Iron and steel is a major exporting and not importing sector. Therefore, we have to assume that its export is subsidized by the state to infer that the closure of the sector increases GDP in the long run. This is a bold statement and seems unlikely at the moment. The only sector whose products are imported in a large degree is chemical manufacturing and, if it goes out of business, the GDP might eventually grow. Yet, taken together, it seems implausible that importing helps if bankruptcy is what Gaddy and Ickes envision for these sectors. Second, our estimate of “new” total GDP is lower than that calculated by the World Bank. Thus, the conjecture that combined effect of the closure on GDP will be positive is overstretched.

These results have been obtained using the assumption that the US prices are representative of the market value of Russian goods, which ignores the problem of quality variation. We have proposed to use the degree of processing as a proxy for quality and considered if accounting for it brings prices closer. The result has been negative implying that quality is not a significant factor that biases our findings.

We have attempted to explain the detected differences in prices by testing several hypotheses both individually and as a group. We have regressed the relative cost of factors to material inputs, barter and receivables shares in revenue, and effective trade tariffs on price ratios. The results indicate that accounting for differences in the values of factors of production explains a significant portion of price differentials. Since we do not discriminate between the difference in quality (as we have assumed before) and the relative cost of factors of production, it is unclear what of two reasons is the most important. Yet, in both cases domestic prices convey information on the market evaluation of goods, which contradicts the proposition that they are 'virtual'.

The use of barter appears to influence Russian prices but only in a multivariate regression. The change in accumulated trade receivables has an insignificant impact. This result suggests that the emphasis on peculiar trade arrangements as being the main driving force determining domestic prices is misplaced.

The positive impact that effective tariff rates have on prices is to be expected according to the theory and it is shown to be present. Yet, the result is not robust and depends on the price control for the sector of gas extraction to stay statistically significant. This finding indicates that domestic traders practically discount tariffs while setting prices.

Finally, we have considered if individual Russian prices possess inertia remained from the Soviet time. Brought to the same numeraire, domestic prices in transition show positive and significant correlation with both pre-transition prices and world level. This finding implies that Russian prices have been relatively inflexible in transition, which leads to two potential interpretations. The first is congruent with the previous statement of politics being involved. It is possible that interest groups remained from the Soviet time resist price changes. Another explanation is that Soviet price administrators did in fact a good job and major market corrections have been unnecessary in transition.[29] The fact that domestic prices have moved closer to world level indicates unequivocally that the Russian economy becomes more open. The last statement seems to be uncontroversial.

Regarding the hypothesis of virtual economy, the evidence is either ambiguous or unfavorable to it. To serve as a building block towards the theory of economic transition, the hypothesis is to be better structured and generate clear predictions. It appears that, in its present form, the hypothesis belongs to the area of bold conjectures, which is not testable by definition.

The general impression from the exercises conducted is that the structure of Russian price system is not well understood. It would be interesting to learn more about what kind of market signals transitional prices convey (or suppress) and why. This line of research will advance our

[29] Taking into account that the Soviet Price Committee (Goskomzen) used the practice of average cost setting (similar to that popularized by Andrei Shleifer in his "A Theory of Yardstick Competition", Rand Journal of Economics, 16, 3: 319-27 Autumn 1985), the statement that market price corrections might be small in transition should not be discounted. The problem of efficient allocation of the factors of production is another matter: given the present disposition of factors, prices can be efficient.

understanding of both the behavior of Russian economy in transition and how markets work after a major shock in general.

The issue of barter and arrears and why they have become so widespread in transition is important in itself. Do non-monetary modes of exchange represent a normal evolutionary development for an emerging market or they are anomalies outside of the market? Answering this question will enable us to better understand the nature of transition and contribute to the discussion that the proponents and opponents of the Washington Consensus continue to lead.

Appendix A: Non-monetary Exchanges in the Russian Transition

Since non-monetary exchanges play a prominent role in the hypothesis, it is necessary to consider how important they were in 1997. Available data is sketchy and we attempt to systematize it here. We divide the presentation in two sections depending on the source of information.

Section A1: Statistical and Survey Data

The existing research on the role that barter and arrears play in transition is built around two sources of information: surveys of industrial enterprises and statistics provided by governmental offices.

Aukutsionek [1998] presents a sample of about 200 companies[30] whose managers have answered the question on the share of barter deals in its sales (see Table A1, sorted by magnitude). This work is apparently the first investigation of the phenomenon of barter in Russia and it has attracted considerable attention.[31]

Table A1: Barter shares in sales for manufacture and agriculture, first half of 1997

	Industry	Barter share in sales, %
1	Construction materials	59
2	Ferrous and non-ferrous metallurgy	56
3	Chemical and petrochemical	52
4	Electricity	46
5	Wood and paper	46
6	Textile, apparel, and footwear	42
7	Machine building and metal processing	41
8	Fuel mining, extraction, and processing	33
9	Agriculture	31
10	Other manufacturing	27
11	Food processing	25
	Memo: Simple average for the sectors	**42**

Source: Aukutsionek [1998], Table 2. Sample size is about 200.

The Institute of Economic Transition [IET, 2001] has conducted a different survey. It uses a sample of about 1,000 enterprises and asks about the importance of barter in both sales and purchases (see Table A2, sorted by magnitude in sales). These two surveys differ by both sectoral organization and time period covered.

The IET finds that the shares of barter in sales and purchases are highly correlated with the correlation coefficient being 0.964. This result is reasonable because the accounting values of exchanged goods should be the same in sales and purchases.

A comparison of both surveys shows that barter was more likely to occur in the sectors of chemical manufacturing and ferrous metallurgy and less likely in food processing. While it is

[30] The English version of the publication explains that the rate of response varied around 200 whereas the number of approached companies was about 500. The Russian Economic Barometer has prepared the questionnaire.

[31] The subsequent work traditionally refers to this paper (see Woodruff [1999, Fig. 4, p.148], Desai and Idson [2000, Table 11.2, p.175], and Treisman [2000] among others).

hard to propose a hypothesis explaining the ubiquity of barter in the first two sectors, the example of food procession suggests that the producers of final goods receive payments in cash relatively more often.

The results obtained in two surveys are somewhat incongruent.[32] This finding indicates that either the share of barter varied in 1997 or sampling errors are present.

Table A2: Barter shares in sales and purchases for manufacture for 1997

	Industry	Barter share in sales, %	Barter share in purchases, %
1	Ferrous metallurgy	64	73
2	Chemical and petrochemical	60	71
3	Machine building and metal processing	60	63
4	Textile, apparel, and footwear	58	60
5	Construction materials	54	64
6	Wood and paper	51	55
7	Non-ferrous metallurgy	38	30
8	Food processing	21	22
	Memo: Simple average for the sectors	**51**	**55**

Source: IET [2001], Tables 1 and 2. Sample size is about 1,000.

Data on tax offsets – that are barter equivalents for government-business relationships – are unavailable in disaggregated form. The website of the Russian Ministry for Taxes and Fees reports that taxpayers contributed 152,004 billion rubles in cash to the Federal Budget and 184,361 billion rubles to other budgets.[33] Given that the total tax collection by the Federal and other levels of government was 243,548 and 328,989 billion rubles respectively,[34] the share of tax offsets to tax collection were 37.6% for the federal and 44.0% for the territorial budgets. If we add the change in tax arrears for 1997 as being implicit subsidies (30,100 and 23,540 billion to the federal and territorial budgets, see GKS [1998b, Table 2.17]), the share of barter and arrears to assessed taxes rises to 44.4% and 47.7% respectively. These numbers are about the same as the share of inter-enterprise barter reported in Tables 1 and 2. This observation is inconsistent with the claim that unwanted goods have been ultimately dumped to the government.

It is reasonable to expect that a part of the bills be paid to the extra-budgetary funds in-kind. Gaddy and Ickes provide anecdotal evidence on social offsets (see Gaddy and Ickes [1998b, Appendix].[35] Yet, we have found no statistical data on the value of offsets that extra-budgetary funds granted to payers.

[32] The correlation coefficient for 7 sectors present in both tables is 0.692, metallurgy combined with the same weight.

[33] See http://www.nalog.ru/stats/new/zhiv97-98-99.shtml

[34] See Table 9 in IET, "*Russian Economy: Trends and Perspectives, Year 1997, Issue 18*", available at http://www.iet.ru/ (in Russian).

[35] They cite a newspaper report that claims that a Samara chemical plant paid in pesticides for some undisclosed obligations and this product eventually became the property of the Pension Fund of the Republic of Mari El. It is unclear from the citation whether the payment was made directly to the Pension Fund or the Federal Government has collected taxes in-kind and transferred the goods to the Pension Fund. The Federal Government is obliged to contribute to the pension funds for federal employees.

Data on the payment of wages in-kind is reported in the Russian Longitudinal Monitoring Survey (RLMS) in section "Adult Questionnaire".[36] We process 4,234 entries, for which matching of the reported occupation with a particular economic sector is possible (job descriptions are taken from the International Labor Organization codes for primary occupations)[37] and present them in Table A3.

Table A3: The share of in-kind payments for a sample of respondents, sorted by magnitude

	Sector	Number of Observations	The share of in-kind payment in total labor income, %
1	Agriculture and forestry	298	35.3
2	Chemical and petrochemical	53	16.5
3	Iron and steel	70	15.3
4	Food processing	45	12.6
5	Coal and other fuels mining	20	12.0
6	Construction	230	11.9
7	Oil extraction	3	11.4
8	Finance, credit, and insurance	15	11.1
9	Machine building and metal processing	464	8.0
10	Transportation	418	7.6
11	Other activities related to production and services	96	6.9
12	Residential, communal, and household services	462	6.1
13	Electricity	87	5.8
14	Trade, intermediation, and food services	493	4.3
15	Oil processing	8	2.7
16	State and commercial management and NGO	540	2.4
17	Textile, apparel, and footwear	58	2.1
18	Health, education, and culture	650	1.8
19	Science, geology, and meteorology	99	1.6
20	Communications	69	1.2
21	Construction materials	13	0.6
22	Wood and paper	23	0.4
23	Other manufacturing	20	0.0
	Memo: Total number and weighted average	**4,234**	**6.4**

Source: Author's calculations based on RLMS, Round 7, Adult Questionnaire.

Table A3 shows that the payment of wages in kind occurs less frequently than inter-enterprise barter. This observation is consistent with the previous suggestion that barter is not common for final goods.

The numbers in tables A1-3 indicate the low bound of non-monetary trade because they apparently exclude specific modes of exchange. Regarding inter-enterprise barter, it is unclear whether the respondents consider such non-monetary means of exchange as bills of exchange issued by large industrial companies. In general, they are expected to be paid in cash on maturity but if a company refuses to honor a bill, the bill holder is presented with a difficult choice. Since initiating bankruptcy is a costly exercise, sometimes it is easier to find a buyer getting paid with a discount. As a result, there is a market for these bills, which begin circulating as quasi-money. Then managers might confuse non-payable (in cash) bills of exchange with money even if the

[36] Round VII. Data were collected for the period from September to November 1996. The web-site of the project is at http://www.cpc.unc.edu/projects/rlms/

[37] See http://www.cpc.unc.edu/projects/rlms/data/occupationalcoding.html for details.

former is traded at heavy discount. As to the wages paid in-kind, the RLMS respondents were asked about goods received in lieu of wages.[38] This question was misleading because it ignored such modes of in-kind payment as credit extended at stores belonging to the firm to cover wage arrears and agreements to pay in-kind for utilities that many firms established with local providers.

Data on arrears come mostly from the State Committee on Statistics (GKS, in Russian abbreviation) that reports overdue credit and debit accounts.[39] In addition, Clarke [1997] supplies numbers on wage arrears that fill gaps for fuel industries. The Center for Economic conjuncture at the Russian Government provides a relatively detailed account on tax arrears for January-September 1997 (see CEC [1998]). Table A4 presents the stock of arrears at the beginning of 1997 and Table A5 details the flows sorted by the share of arrears in sales.

Table A4: Arrears at the beginning of 1997, in percent of sector's revenue for that year, sorted by the share of receivables

		Receivables	Total payables	Trade arrears	Tax arrears	Social Funds arrears	Wage arrears
1	Gas extraction	54.8	62.6	34.2	13.5	5.9	2.1
2	Electricity	31.9	30.6	21.8	3.3	2.8	0.9
3	Coal and other fuels mining	26.9	66.5	19.0	18.7	22.3	7.2
4	Transportation	24.7	23.2	15.1	3.2	2.4	1.1
5	Agriculture and forestry	15.4	18.2	7.2	4.4	4.1	2.9
6	Other manufacturing	14.1	20.6	12.6	2.5	2.7	2.4
7	Oil processing	12.3	15.9	7.0	4.7	2.8	0.3
8	Oil extraction	12.0	27.6	5.8	12.0	6.5	0.8
9	Machine building and metal processing	11.3	31.8	10.5	8.5	7.1	2.7
10	Chemical and petrochemical	11.1	22.2	13.4	3.2	3.0	1.1
11	Iron and steel	10.1	19.6	10.2	3.1	3.7	1.3
12	Non-ferrous metallurgy	10.0	23.6	9.4	5.4	5.9	2.8
13	Textile, apparel, and footwear	9.0	26.8	9.8	7.1	7.2	2.2
14	Wood and paper	8.7	29.5	10.5	7.0	8.1	3.0
15	Construction materials	8.1	15.8	7.2	3.7	3.1	1.6
16	Construction	4.2	22.2	9.4	2.7	7.1	3.5
17	Food processing	2.6	5.7	2.3	1.7	1.1	0.5
18	Residential and communal services*		26.6				
19	Communications*		3.9		1.1		
20	Trade and food services*		2.5				
21	Various sectors*		2.0		1.2		
22	Health, education, and culture						12.4
23	Science						2.8
	Memo: Simple average	15.7	23.7	12.1	5.6	5.6	2.7

Sources: GKS 1998a, Table 6.12; 1998b, Tables 3.58-9; 1998e, various tables related to different sectors; 1999, Table 10.33; and Clarke [1997]. For the sectors with asterisk data on payables are on January 1, 1998. The total payables are larger than the sum of arrears presented in the table because debt owed to other non-financial creditors is omitted.

[38] The question was formulated as "Have you received in the last 30 days at this enterprise in lieu of payment for your labor something from its production or from the production of another enterprise?"

[39] Technically, the overdue credit comprises unpaid bills issued more than 3 months ago.

Numbers in Tables A4 and A5 are aggregates of accounting statements that taxpayers submit to fiscal authorities.[40] Receivables indicate the share of goods and services delivered to customers prior to the payment. They include both normal trade credit and unpaid bills that will be written off as unrecoverable losses in the end. Payables show how much the reporting firm owes to its suppliers, workers, and the government in unpaid taxes. The nature of firm's creditors is detailed in the balance sheet.

Tables A4 and A5 show that the sectors dominated by the state-controlled monopolies (natural gas, electricity, and railroads) and the sector of coal mining are large creditors to the rest of the economy. This observation is consistent with the claim that the government supports the economy by allowing debtors to accumulate unpaid bills to the first three sectors.

Table A5: Change in arrears in 1997, in percent of sector's revenue for that year.

		Receivables	Total payables	Trade arrears	Tax arrears	Social Funds arrears	Wage arrears
1	Electricity	18.7	20.0	12.1	2.4	2.6	0.3
2	Gas extraction	14.6	31.7	2.2	12.8	5.1	-1.3
3	Non-ferrous metallurgy	8.7	8.3	4.3	-0.6	2.8	-0.7
4	Coal and other fuels mining	8.4	37.6	4.3	14.9	13.0	3.0
5	Transportation	8.0	9.0	3.6	2.8	1.3	-0.1
6	Machine building and metal processing	4.5	15.3	4.8	4.8	4.3	0.7
7	Iron and steel	4.1	13.7	8.0	1.8	2.3	0.3
8	Agriculture and forestry	4.0	8.4	2.2	2.4	2.4	0.2
9	Construction materials	3.5	9.2	3.6	2.6	2.4	0.3
10	Other manufacturing[41]	2.8	6.5	2.6	2.5	1.2	17.7
11	Chemical and petrochemical	2.5	10.0	5.2	2.3	1.9	0.4
12	Textile, apparel, and footwear	2.0	15.1	5.2	4.3	4.4	0.5
13	Wood and paper	1.8	15.1	3.6	4.6	5.8	0.8
14	Food processing	1.1	2.9	1.0	0.9	0.7	0.1
15	Construction	1.0	14.7	4.9	2.2	6.2	1.1
16	Oil processing	0.9	7.7	3.4	1.5	2.5	-0.2
17	Oil extraction	-0.7	-4.3	1.5	-2.2	-2.1	0.1
18	Health, education, and culture						-8.6
19	Science						0.3
	Memo: Average	5.0	13.0	4.3	3.5	3.4	1.2

Sources: GKS 1998a, Table 6.12; 1998b, Tables 3.58-9; 1999, Table 10.33. Clarke [1997]

Another observation appears to contradict the subsidizing nature of this credit because large creditors happen to be large debtors as well. This is a general feature of data reported in Table A4.[42] Yet, if we assume that nominal prices are not representative of the market value of goods and services, the contradiction disappears.

The changes in the value of receivables and payables that occurred in 1997 are highly correlated with their stock at the beginning of the year (the correlation coefficients are 0.807 and 0.856

[40] Taxpayers are obliged to submit separate forms to statistical offices but, even if they comply, the forms provide about the same information as to tax authorities.

[41] Data is found as the residual of total manufacturing minus the sum of its other sub-sectors.

[42] The correlation coefficient for 17 sectors of Table 4, for which total value of receivables and payables is reported, is 0.755

respectively). This observation suggests that the trends in arrears were preserved throughout the year.

Section A2: Accounting Estimates of Barter and Arrears

Another source of data that we can explore is accounting information that publicly traded companies disclose following the rules set by the Federal Committee on Securities. While the firms are not required to report the value of bartered goods explicitly, it is possible to derive its proxy using indirect indicators. If the value of total revenue is reduced by the sum of money payments and the positive change in receivables throughout the year, the resulting number is a close estimate of the value of barter in sales. The formula that we use is

$$BarterShareSale = Max\left[Min\left\{ 100\left(1 - \frac{RevenueMoney + Max[\Delta Receivables, 0]}{RevenueTotal} \right), 100 \right\}, 0 \right]$$

Table A6: Average barter and changes in receivables and payables, 1997 (sorted by the magnitude of barter)

	Sector	Barter in sale (%, total sales)	Change in receivables (%, total sales)	Change in payables (%, total costs)	Number of observations
1	Coal mining	73.8	11.3	35.7	54
2	Ferrous metallurgy	69.3	12.8	20.0	83
3	Petrochemical	68.8	13.3	24.3	44
4	Construction materials	64.5	12.2	26.6	152
5	Oil processing	64.1	5.4	6.5	21
6	Automotive	61.6	11.6	38.2	130
7	Processing equipment	58.9	12.4	35.5	91
8	Heavy machinery	57.4	10.8	28.0	143
9	Electricity	56.6	23.3	34.4	92
10	Preserves	52.7	5.1	14.5	45
11	Textiles	52.1	8.5	17.4	114
12	Chemical	51.2	10.2	28.0	89
13	Electric equipment	49.2	14.9	27.4	186
14	Leather and footwear	48.5	6.3	24.7	50
15	Non-ferrous metallurgy	48.2	6.8	17.4	58
16	Oil extraction	46.6	11.7	27.4	36
17	Glass and porcelain	44.8	6.0	21.3	22
18	Wood and paper	44.5	9.7	28.0	130
19	Ship and aircraft building	44.5	20.7	65.6	68
20	Gas extraction	43.4	12.7	32.5	12
21	Butter, milk, and oil	40.3	2.9	6.3	84
22	Agriculture and forestry	39.9	8.6	25.4	172
23	Construction	39.6	21.1	29.9	301
24	Sugar and confectionery	36.5	4.5	8.8	60
25	Financial management	33.0	22.7	35.9	41
26	Science and geology	32.0	18.8	27.9	127
27	Apparel	31.4	13.1	28.1	59
28	Other industries	30.2	16.3	13.7	70
29	Various sectors	29.7	29.8	20.8	16
30	Meat processing	27.7	4.1	7.9	45
31	Trade services	26.1	16.4	20.2	138
32	Transportation	23.6	11.8	13.0	186
33	Medical and cultural services	21.2	8.7	20.1	50
34	Bread and other grains	21.0	3.5	5.5	117

35	Residential services	17.4	29.2	27.4	65
36	Retail and wholesale trade	11.6	9.7	15.4	219
37	Telecommunications	10.6	9.5	10.2	99
38	Liquors, water, and tobacco	10.1	16.0	40.0	84
	Memo: Simple average and number of observations	41.6	12.4	23.9	3,553

Source: Author's sample and calculations. Observations with the change in arrears for more than 500 of total revenue (total costs) have been excluded from the consideration as outlays.

Data on arrears are reported explicitly and we find their share using the formula

$$ArrearsShareX = 100\left(\frac{\Delta Arrears}{X}\right)$$

where X stands for the total revenue or costs depending on what arrears we measure: receivables or payables.

Total revenue is reported in line 10 of the Financial Statement, line 30 of the Report on Money Transactions provides the value of money received for supplied goods and services, and numbers for long and short-term receivables at the beginning and the end of the year appear in lines 230 and 240 of the Balance Sheet. The stock and the change in long and short-term receivables and payables are reported in the Balance Sheet, lines 230, 240, and 620. We report the ratios of the change in receivables to total revenue and the change in payables to the total costs. The latter is presented in line 20 of the Financial Statement.

We have collected accounting and financial information for 3,605 Russian companies for 1997 using a number of sources.[43] The sample includes companies from 78 out of 89 Russian regions and represents a large variety of sectors. For the purpose of presentation, we divide the sample in 38 groups that loosely comply with the industrial classification OKONKh.[44]

Table A6 shows the results that are similar to what other tables present. This finding suggests that accounting information can provide us with reliable data on non-monetary exchanges.

[43] Total number does not correspond with Table A6 because some observations are missing. The main source is the database supported by NAUFOR that is accessible at http://www.skrin.ru. The author expresses his gratitude to Alexander Sumtsov for allowing to use the database. Other sources include regional offices of the Federal Committee for Securities in Moscow, Rostov, and Ufa.

[44] See the Russian State Committee for Statistics "*All-Union Industrial Classification of National Economy*" (OKONKh), Publication 1-75-018, Moscow, January 1, 1976

Appendix B: The Methodology and Data Sources for Price Conversion

We use the input-output table for 1997 as our starting point (see GKS [2000b, Table 4.4]). Since the table contains 10 sectors only and aggregates the most important sectors of mining and manufacturing, the table should be expanded. We disaggregate the sector of mining and manufacturing into fourteen sectors. In addition, sectors of transport and communications, and banking and management are divided into four sectors with obvious names.[45]

Determining values for missing sectors, we follow the procedure that input-output designers usually use. At first, we find total values on costs and revenue. Then we calculate individual cost parameters that sum up to the totals and have the same structure as a base matrix of costs.

Numbers on total output, the value-added, intermediate costs, labor compensation, and indirect taxes for transport, communications, banking, and management come from GKS [2000b, Table 2.13 and 2.25] and we put them in the respective cells of the table. For sub-sectors of mining and manufacturing, total values are not reported in the system of national accounts. We take numbers on the output from the input-output table for 1995 instead (GKS [2000a, Table 4.1]) and adjust them to 1997. The indices of output change in physical units for 1996 and 1997 (GKS [1998a, table 1.9] and the indices of price changes for the same years (GKS [1998a, table 8.1 and 8.4] are used for adjustment

$$Output_{97} = (IndexQ_{96} IndexP_{96})(IndexQ_{97} IndexP_{97}) Output_{95} \qquad [B1]$$

where $IndexQ_{year}$ is the index of the change in output in physical units and $IndexP_{year}$ is the index of the change in prices for the year.

The labor expenses for 1997 are found as a ratio of the ratios of labor cost shares to revenues for 1997 and 1995 times labor expenses taken from the input-output table for 1995. Data on the shares of wage bill and social contributions are from GKS [1998a, Table 7.6] and on the return on costs – from GKS [1998b, Table 3.11]

$$Labor_{97} = \left(\frac{[WageShare_{97} + SocialFeeShare_{97}] / Revenue_{97}}{[WageShare_{95} + SocialFeeShare_{95}] / Revenue_{95}} \right) Labor_{95} \qquad [B2]$$

Gross profits are found similarly with the profit representing the return on costs plus depreciation[46]

$$GrossProfit_{97} = \left(\frac{[(Revenue_{97} / Cost_{97} - 1) + Depreciation_{97}] / Revenue_{97}}{[(Revenue_{95} / Cost_{95} - 1) + Depreciation_{95}] / Revenue_{95}} \right) GrossProfit_{95} \qquad [B2a]$$

We assume that the distribution of mixed profit among industries is identical in structure to the values reported in the input-output table for 1995. Indirect taxes are divided according to the structure of tax collection for 1997 as reported CEC [1998]. The sector of textile and footwear is assumed to stay as the only recipient of subsidies allocated to manufacture in 1997. The value-added at producer's price represents the sum of labor compensation, profits, and net indirect taxes, while the cost of intermediate products is the difference between the total output and the value-added.

[45] The last four sectors are not necessary for our analysis since we do not find its price ratios. We follow the procedure used to construct the input-output table for 1995 that contains 25 sectors (see Ivanenko [2001]).

[46] The depreciation is equal to the capital cost allowances.

After horizontal rows of aggregate numbers for total output are filled, we proceed with vertical rows of aggregate numbers for consumption. To arrive at numbers for intermediate consumption, we subtract net export, final consumption by households, government and NGO, and changes in inventories from the total domestic output. For export (and import), we use the ratio of reported values for 1995 and 1997 (see GKS [1996, Table 357 and 1998c, Tables 3.5, 3.7, and 3.9]) times the value from the input-output table for 1995

$$Export_{97} = \frac{ExportValue_{97}}{ExportValue_{95}} Export_{95} \qquad [B3]$$

The change of inventories for producers is from data on the stock of finished products in GKS [1998a, Table 1.15] apart from the sectors of fuels and other manufacturing. The latter are found by dividing the residual of the total value according to the weights of sectors in the inventories for the input-output table 1995. The change in inventories for consumers is found as the matrix multiplication of the costs of production from the input-output table for 1995 times the changes in the stock of intermediate goods from GKS [1998a, Table 7.7] excluding fuels. The latter sectors are found as the change in physical inventories (see GKS [1998c, Table 2.63]) times average prices for fuels from GKS [1998d, Table 4.11]. We assume that the change of inventories for traders follows the same pattern as reported in the input-output table for 1995. Similarly, the final consumption preserves the same pattern of 1995.

Table B1: Input-output table for 1997 updated using I/O 1997, in billion of rubles

	Electricity	Oil extraction	Oil processing	Gas extraction	Coal and other fuels mining	Iron and steel	Non-ferrous metallurgy	Chemical and petrochemical industry
Electricity	8,911	13,328	3,903	9,011	3,878	13,439	8,803	24,222
Oil extraction	57	549	63,084	0	0	0	0	730
Oil processing	5,064	1,174	1,650	2,052	432	1,634	2,178	2,958
Gas extraction	16,921	0	0	1,402	0	1,582	335	2,480
Coal and other fuels mining	10,476	70	69	72	3,310	10,182	447	574
Iron and steel	727	222	221	229	612	32,437	2,522	2,975
Non-ferrous metallurgy	404	31	31	32	1	1,252	14,220	390
Chemical and petrochemical	1,179	679	676	700	1,423	944	2,411	26,839
Machine building and metal processing	4,913	860	856	887	2,801	4,027	3,757	3,051
Wood and paper	98	28	27	28	334	249	371	1,412
Construction materials	238	34	33	35	138	280	185	523
Textile, apparel, and footwear	1	0	0	0	1	3	1	9
Food processing	21	5	5	5	12	23	28	451
Other manufacturing	547	132	131	136	110	345	213	583
Construction	541	254	253	262	204	655	670	573
Agriculture and forestry	0	3	3	3	0	9	3	20
Transportation	28,782	1,914	7,701	2,130	2,778	13,482	3,321	9,011
Communications	228	592	588	610	860	281	322	547
Trade, intermediation, and food services	13,985	609	3,864	975	1,452	7,751	4,695	5,412
Other activities related to goods and services	648	233	232	240	276	776	450	556
Residential, communal, and household services	170	103	103	107	128	93	144	152

	Electricity	Oil extraction	Oil processing	Gas extraction	Coal and other fuels mining	Iron and steel	Non-ferrous metallurgy	Chemical and petrochemical industry
Health, education, and culture	20	19	19	20	32	12	16	25
Science, geology, and meteorology	187	1,049	1,043	1,081	56	1,009	81	1,600
Finance, credit, and insurance	317	263	262	271	179	148	317	228
State and business management and NGO	184	153	152	158	104	86	184	133
Total intermediate consumption by sector	94,620	22,304	84,907	20,447	19,120	90,701	45,673	85,453
Labor expenses	*27,296*	*9,544*	*8,706*	*3,009*	*11,165*	*18,341*	*17,148*	*19,005*
Gross profit	*65,697*	*45,349*	*24,914*	*28,848*	*7,000*	*11,702*	*22,079*	*4,822*
Net taxes on material inputs and output	18,325	17,452	23,899	8,180	4,465	623	6,529	8,069
Value-added at producer's price	*102,471*	*71,677*	*36,097*	*38,713*	*20,658*	*32,474*	*43,123*	*26,925*
Total output	*205,939*	*94,649*	*142,428*	*60,483*	*41,751*	*121,367*	*91,430*	*117,349*

Sources: GKS 1996, Table 357; 1998a, Tables 1.9, 1.15, 7.6, 7.7, 8.1, 8.4; 1998b, Tables 3.11, 3.23, 3.26; 1998c, Tables 2.63, 3.5, 3.7, 3.9; 1998d, Table 4.11; 2000a, Table 4.1; 2000b, Tables 2.13, 2.25, 4.4; CEC [1998, Table 9], Ivanenko [2001]. Numbers in bold are original numbers from GKS [2000a, Table 4.4], numbers in italics are from other original sources, numbers in plain font are author's calculations.

Table B1 (continued …)

	Machine building and metal processing	Wood and paper	Construction materials	Textile, apparel, and footwear	Food processing	Other manufacturing	Construction	Agriculture and forestry
Electricity	22,374	6,191	9,527	3,333	6,561	3,443	3,213	5,639
Oil extraction	0	0	202	0	0	0	960	0
Oil processing	3,820	2,993	2,097	372	7,236	513	8,519	9,803
Gas extraction	633	0	1,132	158	0	0	0	1,239
Coal and other fuels mining	1,126	473	392	289	819	153	682	649
Iron and steel	25,684	660	3,772	162	897	542	14,495	152
Non-ferrous metallurgy	4,978	122	206	6	384	1,428	347	0
Chemical and petrochemical	8,368	2,529	1,956	4,919	2,972	2,050	4,732	8,730
Machine building and metal processing	62,423	2,947	1,688	814	6,127	1,002	24,084	12,227
Wood and paper	1,726	14,571	825	174	4,259	2,126	5,267	306
Construction materials	673	255	8,422	52	792	93	45,817	959
Textile, apparel, and footwear	7	8	3	252	11	12	3	5
Food processing	58	25	8	125	52,877	869	29	7,019
Other manufacturing	774	116	179	157	1,794	2,490	216	10,041
Construction	587	230	368	127	1,657	183	**1,385**	**1,147**
Agriculture and forestry	1	0	0	667	58,857	3,643	**1**	**87,240**
Transportation	8,246	4,725	6,435	1,671	9,033	1,579	*23,628*	*9,642*
Communications	678	353	320	170	888	150	*1,962*	*1,278*
Trade, intermediation, and food services	13,777	3,068	2,962	4,282	19,922	1,289	**23,185**	**13,266**
Other activities related to goods and services	1,257	211	337	400	1,049	401	**787**	**146**
Residential, communal, and household services	437	105	98	165	527	68	**1,077**	**561**
Health, education, and culture	36	14	10	13	65	16	**61**	**34**
Science, geology, and meteorology	4,451	12	17	15	75	7	**874**	**416**

	Machine building and metal processing	Wood and paper	Construction materials	Textile, apparel, and footwear	Food processing	Other manufacturing	Construction	Agriculture and forestry
Finance, credit, and insurance	755	165	115	212	1,052	85	*1,162*	*105*
State and business management and NGO	439	96	67	123	612	50	*419*	*115*
Total intermediate consumption by sector	163,308	39,869	41,136	18,658	178,467	22,194	**162,906**	**170,718**
Labor expenses	*73,147*	*16,914*	*14,030*	*9,101*	*27,683*	*10,724*	**99,259**	**43,593**
Gross profit	*38,341*	*2,041*	*12,408*	*6,962*	*42,448*	*3,231*	**67,067**	**105,572**
Net taxes on material inputs and output	17,146	2,985	4,048	-3,116	4,159	5,172	**19,498**	**2,682**
Value-added at producer's price	*124,254*	*21,018*	*28,695*	*12,399*	*83,103*	*17,781*	**179,200**	**149,269**
Total output	*291,945*	*61,810*	*71,622*	*31,604*	*252,751*	*41,320*	**348,730**	**322,565**

After the numbers for the sums of the rows and columns are determined, we use RAS procedure to update the input-output table for 1995 to 1997. The procedure is explained in UN [1999] and it is generally used if an input-output table is unavailable for a particular year. We take the variant of the table developed for Ivanenko [2001]. It contains 25 sectors (see Table B1). Finally, banking margin is divided among all sectors taking the data on credits and loans (see GKS [1998b, Table 3.23 and 3.26]) as proxies for sectoral credit rates. We add the margin to the cost of banking services, while transportation and trade margins are added to the intermediate costs of transportation and trade. The table and its constituent parts are shown below.

Having constructed the input-output table, we proceed with finding price conversion rates. We take Russian producer's prices from GKS [1998d, Table 4.11 and 6.8]. Since there is no reported numbers for the sector of other manufacturing, we take consumer's prices for six items belonging to the group GKS [1998d, Table 2.20].[47] The prices for few missing products are deducted in various ways. For bailed hay, the price is from the publication "Methods of calculating pure income in dairy farming" taken as the ratio of the suggested prices for hay and animal feed times the price of animal feed for 1997.[48]

[47] Transportation and trade margins plus net direct taxes might make consumer's prices higher than producer's but we discount this possibility for the group because we have no proxies to adjust the numbers. Besides, the US prices are taken from commercial sources representing consumer prices apart from publishing.

[48] See http://www.aris.krasnodar.ru/metodika2/met2_14.htm

Table B1 (continued …)

	Transportation	Communications	Trade, intermediation, and food services	Other activities related to goods and services	Residential, communal, and household services	Health, education, and culture	Science, geology, and meteorology	Finance, credit, and insurance
Electricity	20,114	665	5,770	154	12,431	4,845	955	715
Oil extraction	0	0	0	0	0	0	54	0
Oil processing	20,030	3,352	15,710	233	22,732	3,167	1,998	1,170
Gas extraction	66	0	0	0	892	0	0	0
Coal and other fuels mining	625	32	917	12	4,455	1,837	45	274
Iron and steel	3,511	237	682	20	3,763	439	630	2
Non-ferrous metallurgy	33	9	11	3	25	16	100	0
Chemical and petrochemical	2,642	711	6,006	75	3,238	21,347	2,507	471
Machine building and metal processing	15,294	3,450	14,806	690	9,531	10,547	5,410	3,052
Wood and paper	1,062	289	6,826	2,418	629	2,556	344	370
Construction materials	1,422	385	4,508	19	4,376	2,217	213	19
Textile, apparel, and footwear	10	3	32	1	11	56	1	7
Food processing	174	46	8,270	20	201	19,132	90	1,011
Other manufacturing	716	196	1,814	1,785	4,833	3,427	286	602
Construction	*2,295*	*326*	**7,146**	**160**	**7,177**	**5,084**	**854**	*672*
Agriculture and forestry	**0**	**0**	**5,198**	**1**	**189**	**3,598**	**79**	*736*
Transportation	*13,442*	*1,883*	*30,135*	*1,144*	*13,066*	*9,603*	*2,318*	*3,196*
Communications	*3,197*	*455*	*8,627*	*262*	*580*	*2,152*	*508*	*877*
Trade, intermediation, and food services	*27,378*	*3,895*	**32,958**	**939**	**8,507**	**13,785**	**1,076**	*2,041*
Other activities related to goods and services	*1,229*	*175*	**8,061**	**950**	**479**	**2,738**	**263**	*430*
Residential, communal, and household services	*2,099*	*299*	**6,781**	**225**	**3,177**	**25,555**	**636**	*4,142*
Health, education, and culture	*115*	*16*	**427**	**26**	**38**	**826**	**12**	*43*
Science, geology, and meteorology	*3,282*	*467*	**1,657**	**75**	**254**	**91**	**15,600**	*661*
Finance, credit, and insurance	*984*	*160*	*1,981*	*82*	*540*	*767*	*150*	*376*
State and business management and NGO	*1,157*	*165*	*2,918*	*80*	*340*	*519*	*101*	*740*
Total intermediate consumption by sector	**120,877**	**17,214**	**171,241**	**9,373**	**101,462**	**134,302**	**34,229**	**21,610**
Labor expenses	**92,641**	**19,941**	**70,656**	**8,606**	**54,527**	**127,314**	**26,043**	**22,547**
Gross profit	**117,015**	**20,524**	**407,232**	**10,099**	**77,264**	**62,898**	**1,306**	**-8,164**
Net taxes on material inputs and output	**32,604**	**5,005**	**21,896**	**1,125**	**8,322**	**9,355**	**3,933**	**4,003**
Value-added at producer's price	**233,421**	**44,213**	**494,837**	**19,667**	**133,620**	**191,707**	**28,543**	**16,493**
Total output	**363,137**	**62,685**	**671,025**	**29,203**	**241,575**	**333,869**	**65,511**	**39,995**

Table B1 (continued …)

	State and commercial management and NGO	Intermediate consumption of sector's product	Final consumption	Change in inventories	Net export	Total use
Electricity	4,639	196,066	7,710	0	2,178	*205,955*
Oil extraction	0	65,636	59	0	28,954	*94,650*
Oil processing	7,606	128,492	4,447	992	8,497	*142,428*
Gas extraction	930	27,770	558	-724	32,870	*60,474*
Coal and other fuels mining	1,777	39,756	759	215	1,022	*41,752*
Iron and steel	13	95,606	96	3,180	22,496	*121,378*
Non-ferrous metallurgy	0	24,030	0	9,270	58,127	*91,427*
Chemical and petrochemical	3,053	111,159	13,063	5,649	-12,522	*117,349*
Machine building and metal processing	24,479	219,724	50,518	117,956	-96,253	*291,946*
Wood and paper	2,401	48,697	11,293	4,914	-3,094	*61,810*
Construction materials	126	71,812	4,161	943	-5,294	*71,622*
Textile, apparel, and footwear	44	480	91,071	3,263	-63,209	*31,604*
Food processing	6,557	97,063	217,299	11,923	-73,477	*252,807*
Other manufacturing	3,907	35,529	4,648	4,737	-3,594	*41,320*
Construction	*4,847*	**37,657**	**7,911**	**307,277**	**-4,115**	**348,730**
Agriculture and forestry	*5,316*	**165,566**	**155,618**	**9,885**	**-8,463**	**322,606**
Transportation	*23,065*	*231,930*	*78,476*	**5,575**	*47,156*	**363,136**
Communications	*6,331*	*32,817*	*24,216*	**0**	*5,650*	**62,683**
Trade, intermediation, and food services	*14,731*	**225,805**	**301,370**	**16,324**	**127,534**	**671,033**
Other activities related to goods and services	*3,107*	**25,432**	**4,639**	**680**	**-1,550**	**29,201**
Residential, communal, and household services	*29,896*	**76,848**	**164,510**	**0**	**219**	**241,577**
Health, education, and culture	*310*	**2,226**	**332,354**	**0**	**-712**	**333,868**
Science, geology, and meteorology	*4,769*	**38,828**	**16,702**	**11,684**	**-1,708**	**65,506**
Finance, credit, and insurance	*2,781*	*13,457*	*26,757*	**0**	*-219*	**39,994**
State and business management and NGO	*5,343*	*14,436*	*314,905*	**0**	*-1,796*	**327,545**
Total intermediate consumption by sector	**156,029**					
Labor expenses	**117,955**					
Gross profit	**39,295**					
Net taxes on material inputs and output	**14,263**					
Value-added at producer's price	**157,858**					
Total output	**327,542**					

The price for wall and floor tiles is from the data on the cost of construction materials for construction purposes adjusted by using the price of brick (see GKS [1998d, Table 5.8]). The price of pulp is connected to the producer's price of paper through the ratio of export prices of pulp and paper. Several prices are from commercial reports of various Russian companies that are assumed to be representative.[49] The prices of methanol and ammonia for three months of

[49] The list of prices contains peat, anthracite, lignite, refractory, ductile iron castings, ferrosilicon, gold, silver, raw diamonds, carbon black, equipment coatings, printing ink, protective footwear, rubber products, ball bearings, welders, switches for electrical circuitry transformers, diodes and rectifiers, electric lighting fixtures, concrete sewer pipe, tableware, manmade silk fabrics, leather handbags, and canned milk.

1997 are from the journal "Prices on Russian Market" published by NIIEMPEX.[50] In total we get a sample of 232 products, which is close to the mark of 256 that Ark and Timmer [2001, Section 3.4] considers sufficient for a comparison of manufacturing.

As a rule, American prices are found as the ratio of the total value divided by the output in physical units. We use for manufacturing and utilities data reported by the Bureau of Census in Current Industrial Reports for 1997 and Census Series EC97. For agriculture data are from Statistical Reports, historical data by the Department of Agriculture and for minerals – from U.S. Geological Survey published by U.S. Department of the Interior. Some missing numbers are taken from trade catalogs or financial reports of large companies.[51] The prices of peat, raw diamonds, live fish, and buckwheat are from Canadian data reported by Statistics Canada and converted in the US Dollars at the market exchange rate. Since American producer's prices are unavailable for irons, sunflower oil, and buckwheat meal, we take prices for close analogues instead.[52] The list of sampled goods is presented in Table B2.

To convert American units into Russian units of measurement, we use a number of formal and informal sources. For example, data on the size of hide in decimeters, density of painting, weights of bushels of grains and fruits are taken from commercial reports. Tables used by the US Bureau of Census, Department of Energy, Ecological Service, US custom officials were helpful as well.

Products are aggregated in 15 groups using Russian industrial classification OKONKh. We take the ratio of the value of a product in the US Dollars to the total value of sampled goods of a sector as the weight and find the price ratio $PriceRatio_i$ for sector I as the ratio of Russian to American prices. After simplifications, the formula for the exchange rate becomes

$$PriceRatio_I = \frac{\sum_{j \in J} Price_j^{Rus} \times Output_j^{Rus}}{\sum_{j \in I} Price_j^{US} \times Output_j^{Rus} \times Factor_j} \qquad [B4]$$

where $Factor_j$ is the conversion factor that accounts for difference in the unit of measurement. Russian output comes mostly from GKS [1998a, Section 11, different tables] but several entries are not available at that source. We use regional data reported by the Russian Ministry of Agriculture, Mineral Group regarding mining, and data from commercial analytical reports to fill the gaps.[53]

Since we ignore Russian prices completely as being unrepresentative of market exchanges, weights do not include a combination of US output measured in Russian prices along with its opposite as it is usually is done in two-country comparative studies.

[50] Available at http://master.chemforum.ru/

[51] The list of prices obtained from informal sources contains polyethylene, polyester, ethylene, methanol, roofing paper, structural concrete, linoleum, dresses and other apparel, books and pharmaceuticals.

[52] Waffle irons, canola oil, and bulgur flour.

[53] See http://dbase.aris.ru/N/WIN_R/INFO/STAT/REG/REG_12_98/ supported by the Ministry of Agriculture and http://www.mineral.ru/publication.html for minerals

Table B2: Average annual prices for 1997 and price ratio for the sample of products

	Product name in English	Sector code	Unit in the US	Unit in Russia	Price of US unit, $ 1	Price of Russian unit, 1,000 rubles	Conversion factor	Price ratio, ruble/$
1	Electricity	ELE	1,000 kW-H	1,000 kW-H	77.0	249	1	3,237
2	Crude petroleum	OIL	Bbl	Ton	17.8	368	7.5	2,765
3	Motor gasoline	OIP	Bbl	Ton	26.9	941	8.5	4,094
4	Light fuel oil	OIP	Bbl	Ton	23.8	953	8.0	5,005
5	Heavy fuel oils	OIP	Bbl	Ton	16.3	433	6.7	3,991
6	Lubricating oils	OIP	Bbl	Ton	47.5	2,069	7.1	6,165
7	Paving grade asphalts	OIP	Bbl	Ton	17.6	588	6.1	5,511
8	Natural gas	GAS	1,000 cu ft	1,000 cu m	2.36	39.90	35.3	478
9	Processed anthracite	COA	S ton	Ton	66.8	140.9	1.1	1,913
10	Processed lignite	COA	S ton	Ton	26.4	78.2	1.1	2,687
11	Peat, CAN	COA	Ton	Ton	113.4	129.0	1	1,137
12	Crude iron ore	FER*	Ton	Ton	8.44	101.1	1	11,976
13	Non-clay refractory	FER*	Ton	Ton	1,725	2,644	1	1,533
14	Pig iron	FER	S ton	Ton	269	1,246	1.1	4,195
15	Ductile iron castings	FER	S ton	Ton	1,313	5,303	1.1	3,664
16	Steel bars	FER	Ton	Ton	437	2,592	1	5,934
17	Carbon steel, sheet	FER	Ton	Ton	640	2,134	1	3,336
18	Cold rolled sheet	FER	Ton	Ton	493	3,189	1	6,471
19	Steel, pipe, and tubing	FER	Ton	Ton	715	3,618	1	5,063
20	All type steel, strip	FER	Ton	Ton	678	5,129	1	7,565
21	Ferrosilicon	FER	S ton	Ton	805	2,232	1.1	2,516
22	Coke	FER*	S ton	Ton	82.89	556	1.1	6,089
23	Bauxite	NFR*	Ton	Ton	24.64	200	1	8,117
24	Primary aluminum	NFR	S ton	Ton	1,367	8,670	1.1	5,753
25	Refined primary cathode copper	NFR	S ton	Ton	1,487	11,754	1.1	7,171
26	Refined zinc	NFR	Ton	Ton	2,323	7,822	1	3,367
27	Primary lead	NFR	Ton	Ton	1,030	4,644	1	4,511
28	Nickel	NFR	Lb	Ton	3.14	38,819	2,205	5,608
29	Tin	NFR	Lb	Ton	3.82	36,950	2,205	4,393
30	Coiled aluminum	NFR	S ton	Ton	2,102	18,744	1.1	8,090
31	Gold	NFR	Kg	Kg	10,694	61,927	1	5,791
32	Silver	NFR	Kg	Kg	157.21	955	1	6,074
33	Raw diamonds, CAN	NFR	Carat	Carat	145.83	470	1	3,220
34	Phosphate rock	CHE*	Ton	Ton	23.79	201	1	8,455
35	Sulfur	CHE	Ton	Ton	35.10	78.18	1	2,228
36	Synthetic ammonia, nitric acid, and ammonium compounds	CHE	Ton	Ton	151.29	860	1	5,684
37	Phosphoric acid	CHE	Ton	Ton	113.47	1,113	1	9,812
38	Potassium salts and boron compounds	CHE	Ton	Ton	167.82	373	1	2,220
39	Sulfuric acid	CHE	S ton	Ton	40.76	261	1.1	5,808
40	Soda ash	CHE	Ton	Ton	85.51	694	1	8,120
41	Caustic soda, sodium hydroxide	CHE	Ton	Ton	139.91	1,713	1	12,241
42	Hydrochloric acid	CHE	S ton	Ton	79.99	252	1.1	2,852
43	Carbon black	CHE	Lb	Ton	0.25	4,887	2,205	8,873
44	Polyethylene	CHE	Lb	Ton	0.21	4,291	2,205	9,159
45	Thermoplastics resins	CHE	Lb	Ton	0.53	1,677	2,205	1,449
46	Polyester	CHE	Lb	Ton	0.69	13,645	2,205	9,025

	Product name in English	Sector code	Unit in the US	Unit in Russia	Price of US unit, $ 1	Price of Russian unit, 1,000 rubles	Conversion factor	Price ratio, ruble/$
47	Rayon	CHE	Lb	Ton	1.15	16,303	2,205	6,430
48	Polyester textile yarn	CHE	Lb	Ton	1.32	25,768	2,205	8,869
49	Equipment coatings	CHE	Gallon	Ton	15.79	4,079	175	1,474
50	Architectural coatings	CHE	Gallon	Ton	10.99	8,992	175	4,668
51	Linseed oil	CHE	Lb	Ton	0.36	4,961	2,205	6,199
52	Printing ink	CHE	Lb	Ton	1.26	237,279	2,205	85,233
53	Styrene-butadiene rubber	CHE	Lb	Ton	0.54	11,936	2,205	10,056
54	Household dry laundry detergents	CHE	Lb	Ton	0.71	5,832	2,205	3,734
55	Ethylene	CHE	Lb	Ton	0.26	2,108	2,205	3,749
56	Methanol	CHE	Ton	Ton	187.00	1,151	1	6,155
57	Ammonia	CHE	S ton	Ton	185.35	851	1.1	4,167
58	Acetone	CHE	Lb	Ton	0.23	3,537	2,205	6,976
59	Light truck pneumatic tires	MAS	Ton	Ton	53.36	904	1	16,940
60	Tractor pneumatic tires	MAS	Ton	Ton	130.29	1,181	1	9,063
61	Radial passenger car pneumatic tires	MAS	Ton	Ton	32.65	219	1	6,721
62	Protective footwear	MAS	Pair	Pair	18.94	6.85	1	362
63	Rubber products	MAS	Ton	Ton	14,521	71,266	1	4,908
64	Diesel engine-driven generator sets	MAS	Unit	Unit	20,655	179,546	1	8,692
65	Underground face haulage vehicles	MAS	Unit	Unit	642,546	280,167	1	436
66	Cranes, lattice boom	MAS	Unit	Unit	393,000	279,308	1	711
67	Wheel cranes	MAS	Unit	Unit	157,849	281,255	1	1,782
68	Locomotives, both new and rebuilt	MAS	Unit	Unit	3,457,446	6,576,479	1	1,902
69	New freight train and passenger train cars	MAS	Unit	Unit	57,344	349,248	1	6,090
70	Motors and generators	MAS	Unit	Unit	123	1,722	1	13,958
71	Prime mover generator sets	MAS	Unit	Unit	3,111	88,963	1	28,596
72	Welders	MAS	Unit	Unit	3,018	26,013	1	8,619
73	Switches for electrical circuitry	MAS	Unit	Unit	1.83	45.98	1	25,091
74	Plate and filament transformers	MAS	Unit	kW	8.03	64.42	5	1,605
75	Diodes and rectifiers	MAS	Unit	Unit	0.24	0.32	1	1,314
76	Electric lighting fixtures	MAS	Unit	Unit	20.36	26.37	1	1,296
77	Electric ranges, ovens, and surface cookers	MAS	Unit	Unit	252.4	1,196	1	4,737
78	Storage batteries	MAS	Unit	Unit	24.21	343	1	14,182
79	Power wire and cable	MAS	Lb	Km	5.83	11,309	1,424	1,363
80	Telephone and telegraph wire	MAS	Lb	Km	4.44	9,317	494	4,252
81	Bare copper wire	MAS	S ton	Ton	2,424	22,366	1.1	8,371
82	Centrifugal pumps	MAS	Unit	Unit	303	7,725	1	25,489
83	Oil well pumps	MAS	Unit	Unit	5,554	32,898	1	5,923
84	Air compressors	MAS	Unit	Unit	948	19,286	1	20,346
85	Trucks	MAS	Unit	Unit	33,826	64,174	1	1,897
86	Passenger cars	MAS	Unit	Unit	15,831	30,831	1	1,948
87	Buses	MAS	Unit	Unit	47,547	58,517	1	1,231
88	Trailers and semi-trailers	MAS	Unit	Unit	2,872	40,291	1	14,027
89	Ball bearings, complete	MAS	Unit	Unit	3.42	13.54	1	3,955
90	Wagons	MAS	Unit	Unit	1,823	12,349	1	6,773
91	Farm-type tractors	MAS	Unit	Unit	22,912	168,945	1	7,374

	Product name in English	Sector code	Unit in the US	Unit in Russia	Price of US unit, $ 1	Price of Russian unit, 1,000 rubles	Conversion factor	Price ratio, ruble/$
92	Plows and sub-soilers	MAS	Unit	Unit	7,563	4,076	1	539
93	Grain drills	MAS	Unit	Unit	17,595	20,130	1	1,144
94	Combines	MAS	Unit	Unit	21,809	212,914	1	9,763
95	Front and rear tractor mounted loaders	MAS	Unit	Unit	2,970	15,567	1	5,241
96	Excavators	MAS	Unit	Unit	103,439	225,264	1	2,178
97	Crawler tractors	MAS	Unit	Unit	147,917	270,833	1	1,831
98	General white lamps	MAS	Unit	1,000 units	0.32	988	1,000	3,058
99	Bicycles	MAS	Unit	Unit	129	455	1	3,532
100	Gas household ranges	MAS	Unit	Unit	331	492	1	1,487
101	Waffle irons	MAS	Unit	Unit	24.1	46	1	1,900
102	Household refrigerators	MAS	Unit	Unit	438	1,457	1	3,326
103	Household laundry machines	MAS	Unit	Unit	263	502	1	1,910
104	Household television receivers	MAS	Unit	Unit	372	614	1	1,652
105	Softwood logs and bolts	FOR	Cu m	Cu m	21.6	137	1	6,342
106	Softwood lumber, edge worked	FOR	1,000 bd ft	Cu m	0.55	389	588	1,200
107	Softwood, not edge worked	FOR	1,000 bd ft	Cu m	0.39	294	588	1,270
108	Panel Douglas fir doors	FOR	Unit	Sq m	119	150	0.38	3,331
109	Double hung wood windows	FOR	Unit	Sq m	168	269	0.56	2,858
110	Interior softwood plywood	FOR	Sq ft, 3/8	Cu m	0.23	2,040	1,689	7,934
111	Particleboard	FOR	Sq ft, 3/4	Cu m	0.28	743	1,392	4,703
112	Wafer- and oriented strandboard	FOR	Sq ft, 3/4	Sq m	0.12	4.24	10.8	3,407
113	Wood tables	FOR	Unit	Unit	189	338	1	1,789
114	Wood chairs	FOR	Unit	Unit	68	118	1	1,721
115	Upholstered wood sofas	FOR	Unit	Unit	335	1,207	1	3,602
116	Clay-coated paper	FOR	S ton	Ton	769	2,935	1.1	3,461
117	Unbleached linerboard	FOR	S ton	Ton	334	2,987	1.1	8,122
118	Sulfate wood pulp	FOR*	S ton	Ton	439	3,279	1.1	6,779
119	Portland cement	CSM	S ton	Ton	66	237	1.1	3,234
120	Roofing paper	CSM	Sq ft	1,000 sq m	0.02	3,086	10,764	11,872
121	Structural concrete	CSM	Cu yard	Cu m	303	868	1.31	2,191
122	Prestressed concrete panels	CSM	Sq ft	Cu m	4.77	868	90	2,029
123	Gypsum plaster building boards	CSM	S ton	1,000 stand. Bricks	128	520	4.19	974
124	Concrete sewer pipe	CSM	S ton	Standard m	109	17.59	0.01	17,195
125	Brick	CSM	Unit	1,000 bricks	0.17	611	1,913	1,837
126	Clay tile	CSM	Sq ft	Sq m	1.37	39.68	11	2,682
127	Quicklime	CSM	S ton	Ton	54.1	229	1.1	3,833
128	Mined gypsum	CSM	Ton	Ton	7.10	351	1	49,424
129	Construction gravel	CSM	S ton	Ton	5.21	41.59	1.1	7,235
130	Construction sand	CSM	S ton	Ton	4.34	30.35	1.1	6,343
131	Asbestos	CSM	Ton	Ton	222	934	1	4,205
132	Linoleum	CSM	Sq yard	Sq m	9.50	23.89	1.2	2,103
133	Flat glass, construction	CSM	Sq ft	Sq m	0.30	15.15	10.8	4,699
134	Flat glass, window	CSM	Sq ft	Sq m	0.30	12.75	10.8	3,955
135	Tableware	CSM	Unit	Unit	1.26	5.22	1	4,133
136	Carded cotton yarns	TEX*	Lb	Ton	1.37	16,495	2,205	5,454
137	Cotton broad woven fabrics	TEX	Sq yd	Fabric m	1.38	3.96	1.2	2,398
138	Wool yarns	TEX*	Lb	Ton	4.11	28,347	2,205	3,125
139	Wool broad woven fabrics	TEX	Sq yd	Fabric m	3.03	37.50	1.2	10,340

	Product name in English	Sector code	Unit in the US	Unit in Russia	Price of US unit, $ 1	Price of Russian unit, 1,000 rubles	Conversion factor	Price ratio, ruble/$
140	Manmade silk fabrics	TEX	Sq yd	Sq m	4.47	9.64	1.2	1,803
141	Sheer hosiery	TEX	Doz pairs	Pair	2.79	4.91	0.08	21,133
142	Women’s hosiery	TEX	Doz pairs	Pair	6.74	4.53	0.08	8,076
143	Men’s hosiery	TEX	Doz pairs	Pair	7.87	2.99	0.08	4,562
144	Children’s finished anklets	TEX	Doz pairs	Pair	5.66	6.36	0.08	13,489
145	Men's underwear	TEX	Unit	Unit	1.24	7.24	1	5,863
146	Men's and women's sweaters	TEX	Unit	Unit	12.95	42.3	1	3,264
147	Men's overcoats	TEX	Unit	Unit	69.2	242	1	3,494
148	Women's & girls' apparel dresses	TEX	Unit	Unit	24.4	56.1	1	2,295
149	Men's & boys' woven dress shirts	TEX	Unit	Unit	11.7	27.9	1	2,384
150	Men's dress coats	TEX	Unit	Unit	62.4	187	1	2,987
151	Sheet sets	TEX	Dozen	Unit	216	29.8	0.08	1,654
152	Upholstery leather	TEX	Sq ft	Sq dm	2,944	1,162	0.11	3,665
153	Wet blues leathers	TEX	Sq ft	Sq dm	8,529	732	0.11	797
154	Upper leather	TEX	Sq ft	Sq dm	2,374	726	0.11	2,840
155	Women’s handbags	TEX	Unit	Unit	21.9	51	1	2,308
156	Men’s footwear	TEX	Pair	Pair	48.5	125	1	2,575
157	Beet sugar	FOO	S ton	Ton	576	2,671	1.1	4,210
158	Rye bread	FOO	Lb	Ton	0.80	2,197	2,205	1,247
159	White pan bread	FOO	Lb	Ton	0.62	3,744	2,205	2,737
160	Sweetened chocolate	FOO	Lb	Ton	1.10	16,451	2,205	6,756
161	Cookies and wafers	FOO	Lb	Ton	1.43	7,418	2,205	2,355
162	Crude soybean oil	FOO	Lb	Ton	0.23	3,735	2,205	7,378
163	Spoon-type mayonnaise	FOO	Gallon	Ton	4.02	8,671	240	8,968
164	Dry macaroni	FOO	Lb	Ton	0.59	4,188	2,205	3,231
165	Complete chicken feed**	FOO	S ton	Ton	188	958	1.10	4,613
166	Bottled unprocessed whiskey	FOO	Wine gal	10 liters	14.15	43.38	2.64	1,161
167	Bottled vodka	FOO	Wine gal	10 liters	11.39	54.08	2.64	1,797
168	White grape wines	FOO	Wine gal	10 liters	6.30	69.38	2.64	4,169
169	Canned beer	FOO	Case	10 liters	27.54	29.08	2.35	450
170	Bottled carbonated soft drinks	FOO	Case	10 liters	3.36	20.77	1.76	3,505
171	Compressed yeast	FOO	Lb	Ton	0.32	4,577	2,205	6,405
172	Canned beans, corn, and tomatoes	FOO	Case	Ton	8.10	2,701	35.2	9,468
173	Canned milk	FOO	Lb	Standard can	0.64	2.24	0.88	3,968
174	Tea	FOO	Lb	Ton	4.91	18,444	2,205	1,705
175	Table salt, evaporated	FOO	S ton	Ton	384	504	1.1	1,189
176	Filter tip cigarettes	FOO	1,000s	1,000s	40.2	26.06	1	649
177	Beef	FOO	Lb	Ton	1.06	10,903	2,205	4,662
178	Smoked sliced bacon	FOO	Lb	Ton	1.45	13,828	2,205	4,312
179	Wet ice pack broilers	FOO	Lb	Ton	0.56	11,474	2,205	9,354
180	Other sausage	FOO	Lb	Ton	1.65	18,087	2,205	4,963
181	Regular yogurt	FOO	Lb	Ton	0.79	3,366	2,205	1,936
182	Sour cream	FOO	Qt	Ton	0.85	9,579	1,057	10,612
183	Natural cheese	FOO	Lb	Ton	1.40	18,627	2,205	6,031
184	Process cheese	FOO	Lb	Ton	1.84	13,677	2,205	3,365
185	Creamery butter	FOO	Lb	Ton	1.13	20,390	2,205	8,198
186	Fluid whole milk	FOO	Lb	Ton	0.15	2,265	2,205	7,053

	Product name in English	Sector code	Unit in the US	Unit in Russia	Price of US unit, $ 1	Price of Russian unit, 1000 rubles	Conversion factor	Price ratio, ruble/$
187	Prepared fresh fish	FOO	Lb	Ton	1.81	5,667	2,205	1,418
188	Prepared frozen fish	FOO	Lb	Ton	1.30	3,792	2,205	1,327
189	Finfish, CAN	FOO	Ton	Ton	4,056	9,995	1	2,464
190	Salted and pickled fish	FOO	Lb	Ton	1.41	8,422	2,205	2,707
191	Canned salmon	FOO	Lb	Standard can	1.30	4,252	882	3,702
192	White bread flour	FOO	Sack	Ton	11.46	1,965	22	7,774
193	Whole cornmeal	FOO	Sack	Ton	11.97	1,751	22	6,635
194	Bulgur flour	FOO	Sack	Ton	21.26	3,012	22	6,426
195	Semolina	FOO	Sack	Ton	14.20	2,574	22	8,222
196	Head rice	FOO	Lb	Ton	0.11	2,826	2,205	12,191
197	Newspaper	OTH	Unit	Unit	1.33	0.76	1	575
198	Book	OTH	Unit	Unit	15.65	16.04	1	1,025
199	Aspirin	OTH	Pack, 5 g	Pack, 5 g	1.49	0.99	1	668
200	Nitroglycerin	OTH	Pack, 15 mg	Pack, 5 mg	29.94	0.35	0.33	35
201	Erythromycin	OTH	Pack, 25 g	Pack, 2.5 g	18.53	7.80	0.10	4,210
202	Vitamin C	OTH	Pack, 120 g	Kg	14.61	114	8.33	940
203	Wheat	AGR	Bu	Ton	3.38	599	37	4,825
204	Rye	AGR	Bu	Ton	3.75	580	39	3,927
205	Buckwheat, CAN	AGR	Bu	Ton	4.69	978	39	5,296
206	Corn for grain	AGR	Bu	Ton	2.43	784	39	8,194
207	Barley	AGR	Bu	Ton	2.38	476	46	4,357
208	Soybeans	AGR	Cwt	Ton	12.10	879	22	3,293
209	Oat	AGR	Bu	Ton	1.60	492	69	4,465
210	Sunflowers seeds	AGR	Cwt	Ton	11.60	749	22	2,927
211	Sugar beets	AGR	Ton	Ton	38.80	183	1	4,719
212	Potatoes	AGR	Cwt	Ton	6.11	940	22	6,984
213	Tomatoes	AGR	Cwt	Ton	31.74	3,605	22	5,152
214	Cucumbers	AGR	Cwt	Ton	17.69	4,808	22	12,331
215	Onions	AGR	Cwt	Ton	11.20	886	22	3,591
216	Garlic	AGR	Cwt	Ton	47.91	5,429	22	5,140
217	Cabbages	AGR	Cwt	Ton	10.81	977	22	4,099
218	Carrots	AGR	Cwt	Ton	12.88	1,093	22	3,846
219	Beets	AGR	Ton	Ton	66.65	987	1	14,802
220	Cherries and peaches	AGR	Lb	Ton	0.24	1,255	2,205	2,364
221	Apples and pears	AGR	Lb	Ton	0.15	685	2,205	2,091
222	Strawberries	AGR	Cwt	Ton	55.50	4,259	22	3,481
223	Grapes	AGR	Lb	Ton	0.19	1,192	2,205	2,789
224	Honeydews & watermelons	AGR	Cwt	Ton	8.85	300	22	1,536
225	Cattle and calves	AGR	Lb	Ton	0.61	3,448	2,205	2,578
226	Sheep and lambs	AGR	Lb	Ton	0.81	2,410	2,205	1,345
227	Hogs and pigs	AGR	Lb	Ton	0.52	6,149	2,205	5,329
228	Broilers	AGR	Lb	Ton	0.38	6,055	2,205	7,282
229	Milk	AGR	Lb	Ton	0.14	975	2,205	3,267
230	Eggs	AGR	Unit	1,000s	0.06	372	1,000	6,348
231	Wool	AGR	Lb	Ton	0.84	3,943	2,205	2,134
232	All hay, baled	AGR*	Ton	Ton	100	92	1	919

Sources: Prices per US unit are from US Bureau of Census, US Department of Agriculture, US Department of Interior (recalculated as the ratio of total value to output in physical units), different publications and several commercial sources; prices per Russian unit are from GKS [1998d, Table 4.11, 2.20, 6.2] and commercial sources; conversion factors are from US Department of Energy, US Bureau of Census and Russian and American

commercial sources; Price ratios are the ratios of Russian prices to the product of US prices times conversion factor. CAN means that Canadian values are used converted in US dollars, * implies that the product is used by the sector internally, ** defines the only product (chicken feed) that is consumed by a specific sector

Some products are consumed by one sector and they are counted for that sector only. This is not vital for our research but it should improve the accuracy of our results. We consider iron ore, coke, bauxite, pulp, yarns, animal feed, and hay to be products intended for internal consumption. They are not included in the sample of products that are used by more than one sector. As it is seen in Table B3, the price ratios for products consumed within sectors and in general do not differ much.[54]

Table B3: Sectoral price ratios, in rubles per dollar.

	Sector	Code	Price ratio: General consumption	Price ratio: Internal consumption
1	Electricity	ELE	3,237	The same
2	Oil extraction	OIL	2,765	The same
3	Oil processing	OIP	4,488	The same
4	Gas extraction	GAS	478	The same
5	Coal and other fuels mining	COA	2,005	The same
6	Iron and steel	FER	4,103	4,114
7	Non-ferrous metallurgy	NFR	3,942	3,973
8	Chemical and petrochemical industry	CHE	5,368	5,393
9	Machine building and metal processing	MAS	2,210	The same
10	Wood and paper	FOR	2,875	3,349
11	Construction materials	CSM	2,583	The same
12	Textile, apparel, and footwear	TEX	2,898	3,134
13	Food processing	FOO	2,499	The same
14	Other industries	OTH	794	The same
15	Agriculture and forestry	AGR	4,418	4,257
	Memo: PPP price ratio[55]		**2,384**	

Sources: Author's calculations

The generic formula for finding the matrix of intermediate costs $\mathbf{Table}_{\mathbf{PPP}}$ converted at the sectoral Price ratios is

$$\mathbf{Table}_{\mathbf{PPP}} = \mathbf{Rate}^{-1} \circ \mathbf{Table}_{\mathbf{I/O97}} \qquad [B5]$$

where **Rate** is a diagonal matrix of the rates. In actual calculations, we divide the entries of the input-output matrix by the relevant rates element by element because for several diagonal entries internal Price ratios should be used.

[54] It is interesting to note that items that are produced and consumed within sectors tend to be over-priced relative to its other products. The sample is too small to make any inference what forces might be at play

[55] It is found as the ratio of GDP in rubles to the estimate of GDP at PPP exchange rates made by the World Bank.

Appendix C: The Methodology of Finding the Value of Import Barriers

To determine import barriers, we compare American producer's prices of our sample[56] with Russian prices. If the US price is higher, tariff does not serve as a trade barrier because import is unprofitable. If a Russian price is higher, two situations are possible: tariff markup is lower or higher than the difference in prices. If the tariff is higher, Russian producers do not charge the whole tariff markup. Then, tariff protection accounts for the difference in prices. If the tariff is lower, there is assumed to be an internal factor responsible for non-tariff markup. In this case, tariff rate determines the level of protection. Technically, the formula for finding the rate of price protection for good *j* is

$$Rate_j = \begin{cases} 0, & if\ Price_j^{Rus} - Price_j^{US} \times Factor_j \times Exchange_{Rus/US97} \le 0 \\ Min\left[\dfrac{Price_j^{Rus}}{Price_j^{US} \times Factor_j \times Exchange_{Rus/US97}} - 1, Tariff_j \right], & otherwise \end{cases} \qquad [C1]$$

We take import tariff rates as they are reported in the Governmental Decree N 1560 "On the Classification of Products Designated for Foreign-Trade and Custom Tariffs of the Russian Federation" dated December 27, 1996.[57] Correspondence of goods to tariffs is checked using "The Classification of Goods for External Trade of the CIS" by State Custom Committee of the RF, edition of September 19, 1996.[58] Some tariffs are accessed in ECU per unit of a product. To convert unit in ad valorem rates, we multiply the levy by average daily exchange rate for ECU for 1997 set by the CBR and divide by the Russian price of the good in question[59] as

$$Rate_j = \frac{RateECU_j \times ExchangeRate^{97}}{Price_j^{Rus}} \qquad [C2]$$

After protection rates are found for each product, we find sectoral protection barriers. At first, the values of import barriers are found as the product of protection rates and non-exported domestic output

$$Value_j = \frac{Rate_j \times Price_j^{Rus} \times (Output_j - Export_j)}{1 + Rate_j} \qquad [C3]$$

The export share is excluded from the consideration since it is assumed that external trade is conducted at market prices. This assumption might be violated in transactions with the former Soviet states, for prices of products shipped to and received from the CIS countries are generally lower than the average. Nevertheless, we do not expect export prices to change when import tariffs are annulled and exclude exports from the estimated value of tariff protection.

We get data on export values from GKS [1998c, Table 3.9]. When data on the export of a particular good is missing or aggregated, we use the average export share for the sector available from the input-output table instead.

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[56] US prices are converted in rubles at the average daily CBR exchange rate, which was 5,785 ruble/US $.

[57] The decree is available at http://www.ist.ru/VP/LIB053/z10500.htm#P_47. There were no changes of rates during 1997 relevant to our sample apart from rising tariff rate on tea from 10 to 20 percent from June 1.

[58] See Ministry of Economic Development and Trade of the RF at http://www.inves.ru/info/online/tnved/.

[59] In our sample such levy applies to sweetened chocolate only.

The term in denominator appears because tariff rate applies to the foreign price of imported goods. Thus, if the Russian price differs from its foreign analogue by the tariff margin only, it should be equal to

$$Price_j^{Rus} = (1 + Rate_j) \times Price_j^{US} \qquad [C4]$$

which is introduced into formula [C3]. Finally, the sectoral protection rates are found as the ratio of the total values of import barrier and the value of output of the sampled goods.

Table C1: Weighted average tariff and sectoral protection rates

	Sector	Code	Average effective rate, in %	Tariff and price protection rate, in %
1	Electricity	ELE	5.000	0.000
2	Oil extraction	OIL	5.000	0.000
3	Oil processing	OIP	5.000	0.206
4	Gas extraction	GAS	5.000	-41.140
5	Coal and other fuels mining	COA	5.000	0.000
6	Iron and steel	FER	5.268	0.324
7	Non-ferrous metallurgy	NFR	17.872	0.135
8	Chemical and petrochemical industry	CHE	9.302	3.636
9	Machine building and metal processing	MAS	23.402	0.781
10	Wood and paper	FOR	17.601	2.993
11	Construction materials	CSM	9.863	0.975
12	Textile, apparel, and footwear	TEX	19.463	2.605
13	Food processing	FOO	16.801	3.675
14	Other industries	OTH	2.291	0.000
15	Agriculture and forestry	AGR	12.477	4.322

Sources: Tariff rates are aggregated by the author using individual rates from the Governmental Decree N 1560 "On the Classification of Products Designated for Foreign-Trade and Custom Tariffs of the Russian Federation" dated December 27, 1996 and weights calculated from the sample presented in Table A2; tariff and price protection rates are author's calculations

Table C1 presents the sectoral protection rates. Note that the rate for natural gas extraction is negative because the average export price of gas (unregulated) exceeds its domestic price (regulated).[60] The situation is reversed for electricity where its domestic price (regulated) is higher than the average export price. This observation implies that the domestic price of gas is lower than it would be with no price regulation and perfect competition whereas the price response of electricity sector in similar conditions is uncertain.

[60] We take the average price of natural gas that manufacturing establishments pay and not producer's price for this exercise. The reason is that it is the former price that is fixed by the government. It includes transport and trade margin. The average price for manufacturing establishments is from GKS [1998e, Table 24.23]. However, considering the value of output if prices are unregulated, we add trade and transport margins to the sector of gas extraction and subtract this amount from the output of transport and trade sectors. The difference is divided between the last sectors in the proportion to their total margins for the whole economy.

Appendix D: The Methodology of Finding the Index of Processing

We start with finding the shares of processing for mixed sectors. Russian industrial classification OKONKh details what establishments are considered to be primary (extraction and mining). We take the classification as the base and draw a list of primary products. They are:

- Electricity[61]
- Oil and gas extraction and coal mining
- Ore and non-ore mining for ferrous and non-ferrous metallurgy including diamonds mining
- Chemical mining (apatite, nepheline, phosphates, potassium, natural sulfur, boron, arsenic, barite, and iodine)
- Unprocessed lumber for the sector of wood and paper
- Stones, sand, and clay used for construction purposes (ceramic clay, gravel and construction sand, marble, granite and other decorative stones, limestone, asbestos, kaolin, talcum, pegmatite, mica, and quartz sand
- Table salt and prepared and fresh fish for food processing sector
- Precious and semi-precious stones for the sector of other manufacturing

We define the share of primary production as the value of sectoral primary output to its total value. The values of unprocessed lumber, table salt, and fish are found as the product of average producer price and total output that we have collected in the sample. Data on total output for these sectors is from GKS [1998e, Tables 14.67 and 14.76].

Data on the shares of primary production for other sectors is unavailable in statistical publications. We use the sample of 3,211 companies to find approximate shares by separating the sample into primary and processing establishments and aggregating its output.[62] The shares are reported in Table D1.

[61] OKONKh divides the sector of electricity in primary (hydroelectric power stations) and processing (coal, gas, and nuclear power stations). We consider the whole sector to belong to primary industry.

[62] This is a reduced form of the sample that we introduce in Appendix A, Section A2. It is representative with the smallest number of firms being in the sector of non-ferrous metallurgy (57 companies). The estimate for the only sector that can be double-checked (wood and paper) shows that the difference in the estimated shares of processed goods is less than 10 percent (88 vs. 84 percent).

Table D1: The shares on processed goods in total output and the index of processing

	Sector	The share of processed goods	The index of processing
1	Electricity	0.000	1.000
2	Oil extraction	0.000	1.000
3	Oil processing	1.000	0.584
4	Gas extraction	0.000	1.000
5	Coal and other fuels mining	0.000	1.000
6	Iron and steel	0.897	0.657
7	Non-ferrous metallurgy	0.641	0.601
8	Chemical and petrochemical industry	0.957	0.606
9	Machine building and metal processing	1.000	0.364
10	Wood and paper	0.838	0.552
11	Construction materials	0.965	0.467
12	Textile, apparel, and footwear	1.000	0.494
13	Food processing	0.954	0.593
14	Other industries	1.000	0.410
15	Agriculture and forestry	0.000	1.000

Sources: Author's calculations

After the shares of primary production are found, we calculate the index of processing. This concept is to be defined before we can proceed. It deals with the accumulation of value that is added on each stage of processing to the unit value of the primary goods. Mathematically, the problem is to find the variable *Index* such that

$$\mathbf{Revenue} \bullet \mathbf{Index} \bullet \mathbf{i} = \mathbf{Cost}^{T} \bullet [\mathbf{I} - \mathbf{Share} + \mathbf{Share} \bullet \mathbf{Index}] \bullet \mathbf{i} \qquad [D\mathbf{1}]$$

where $\boldsymbol{Cost}^{\boldsymbol{T}}$ is the transposed matrix of costs, ***Revenue***, ***Share***, and ***Index*** are diagonal matrices of the sectoral revenue, the share of processing, and the index of processing respectively and ***i*** is the identity vector. Data on costs and revenues come from the input-output table for 1997 (see Table B1).

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