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Working Paper Series Vol. 2003-36
November 2003

The International Centre for the Study of East Asian Development, Kitakyushu

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Abstract

This paper first analyzes the major trends in Korea's steel industry in the 1990s, highlighting the prominent role of overcapacity. Overcapacity resulted both from chronic overinvestment in past years and the collapse of domestic demand following the economic crisis, which led to a large depreciation of the won in December 1997 followed by a large economic contraction in 1998. After the crisis a number of Korean firms, including a few medium-sized steel firms, became insolvent and had to cease operations, while other firms suspended or cancelled planned investments. Steel firms also began to downsize, reducing employment substantially in 1997-1998, and it seems clear that the days of rapid growth in this industry are over in Korea. The crisis also led to large policy changes, including the accelerated privatization of the largest steel firm, POSCO, which was previously state-owned. The paper then analyzes the role of international trade in Korean steel, highlighting its relatively small size in most years and the important role the large increase of exports played in 1998 as a buffer for Korean steel makers in the midst of the crisis. Finally, the paper uses a simple model of interactions between domestic steel demand and macroeconomic variables to illustrate how exchange rate adjustments played a particularly important role in the recovery of Korea's steel industry after the crisis.

1. Introduction

In 1998, Korean economic growth plunged as the country felt the consequences of the financial crisis that became evident in late 1997. Three major factors have been suggested as major causes, (1) the financial insolvency which resulted from corporate insolvency, (2) liberalization of financial markets without adequate supervision of financial institutions, and (3) a weak response to instability in international financial markets (Korean Development Institute 1999). In Korea, corporate insolvency has generally been regarded as a particularly important cause of the crisis and this insolvency had stemmed from the existence of overcapacity in several industries. Although the financial crisis affected the steel industry less severely than the rest of Korean manufacturing, Korea's steel industry also had an overcapacity problem which resulted from chronic overinvestment and the overcapacity problem was severely exacerbated by the fall in steel demand after the crisis. Correspondingly, in order to insure their survival, Korean steel makers have had to devote substantial resources to dealing with the overcapacity problem after the crisis. The purpose of this paper is thus to describe major trends in the Korean steel industry during the 1990s, focusing on how the overcapacity problem and the consequences of the crisis have affected the industry.

To this end, section 2 will first describe the evolution of the overcapacity problem and how Korean steel makers have restructured their operations to cope with the problem after the crisis. The role of trade in steel products in the adjustment process is examined in section 3, focusing on how exports served as a buffer for Korean steel makers, especially at the height of the crisis. Trends in domestic steel demand and their relationships to major macroeconomic trends, especially trends in exchange rates, are then analyzed in the context of a simple macroeconometric model in section 4. Finally, section 5 summarizes the major conclusions emerging from this study.

2. Korea's Steel Industry in the 1990s: Overcapacity and Corporate Restructuring

Overcapacity has been a long-standing problem in Korea's heavy industries that resulted in large part from the government-led drive toward heavy industrialization in the 1970s. Related problems, including those related to extremely rapid growth in the steel industry first contributed to macroeconomic problems in 1980 when the economy registered negative growth (Bank of Korea 2003).[1] Despite significant reforms following this slowdown, the government continued to intervene in both output and factor markets related to heavy industries in the 1980s and the early- to mid-1990s. This intervention generated moral hazard that exacerbated the excess capacity problem (East Asia Analytical Unit 1999). The costs of this intervention were largely unrecognized during this period, partially because economy grew extremely rapidly in most years (8.6 percent annually or more in 1983-1984, 1986-1991, and 1994-1995, Bank of Korea 2003). As a result of these factors, steel output continued to grow rapidly in the 1980s, albeit at a much slower pace than in the 1970s.[2]

As a result of this growth production capacity and steel output reached an average of 28 million tons, 14 trillion current won, or US$18 billion in 1990-1992 (Tables 1, 2). Moreover, continuing large investments, primarily by producers using electric arc furnaces, led to further substantial increases between 1990-1992 and 1993-1996, when capacity grew 35 percent and production grew 36 percent if measured in tons, and the value production grew 44 percent if measured in real won, 54 percent in current won, and 43 percent in U.S. dollars.[3] The increase in capacity resulted primarily from aggressive expansion by steel makers that use electric arc furnaces in production. This expansion followed a shortage of construction materials such as reinforced bar in the early 1990s, which are primarily produced with electric

[1] According to the United Industrial Development Organization (2002), Bank of Korea (2003) and International Monetary Fund (2003), the value of steel output increased over 42 times in 1970-1980 if measured in current won, over 38 times in constant won and over 21 times if measured in U.S. dollars.

[2] According to the United Industrial Development Organization (2002), Bank of Korea (2003) and International Monetary Fund (2003) the value of steel output increased over 4.3 times in 1980-1990 if measured in current won, over 3.0 times in constant won and over 3.7 times if measured in current U.S. dollars.

[3] Average capacity measured in tons increase 35 percent between 1990-1992 and 1993-1996 while corresponding increases in output were 36 percent if measured in current won and 43 percent increase if measured in current U.S. dollars (Table 1)

arc furnaces. In contrast the single producer using a basic oxygen furnace in production, Pohang Steel or POSCO, expanded much more slowly.

Another 51 companies produced rolled products without using furnaces of any type in 2000. 28 of these companies were engaged in the production of long products and 22 in the production of flat products. The capacity of these firms is not generally counted as part of the steel industry's capacity, which is based on the capacity to produce crude steel, not finished steel. In case of flat products, overcapacity in rolling facilities causes shortage of intermediate products, mainly plates, and oversupply of finished products, mainly sheets. This characteristic affects Korea's pattern of trade in steel products as discussed later.

Korean steel makers with excess capacity were extremely vulnerable when the currency crisis hit the economy in late 1997. Two mid-sized steel makers that expanded rapidly, Hanbo Steel and Sammi Steel, incurred heavy debts and started a rash of corporate bankruptcies in 1997. After the crisis, Korea's steel makers sought alleviate the excess capacity problem in various ways (Table 3). These included abandoning construction of some new facilities (POSCO, Hanbo Steel), suspending some operations (Hanbo, others), and closing down some factories (Dongkook Steel Mill, Seoul, others). The total amount of capacity reduced by these measures was over 11 million tons of crude steel, including the 6 million ton capacity of Hanbo's section B. It should be emphasized that the majority of the capacity affected by these actions was to be added to existing capacity and that a relatively small amount of existing capacity was permanently closed down. On the other hand, it is also important to recognize that Korean steel firms began to reduce their workforce early in the 1990s, with average employment in steel plants declining from 77,959 in 1990-1992 to 74,590 in 1993-1996 and only 65,336 in 1998-2001 (Table 2). In this respect, downsizing actually began well before the crisis.

Korean steel firms have also used mergers and acquisitions, strategic alliances, and foreign investment to restructure their operations. For example, INI Steel acquired Kangwon Industries and Sammi Steel to form the world's second largest electric arc furnace producer in

2000.[4] Kia Steel was acquired by Sea Consortium and Hanbo Steel is in the process of being sold to AK Capital. POSCO, which was a government-controlled firm, was privatized as part of the public sector reform process in 2000. POSCO also swapped shares with Nippon Steel prior to privatization and the two companies formed a strategic alliance covering many operations, such as new technology development, raw material procurement, and foreign transaction systems.[5] Finally, Hyundai Hysco and Dongkook Steel Mill attracted foreign investment from Japan.

Despite substantial restructuring, total production capacity continued to increase immediately after the crisis, from 43 million tons in 1997 to 49 million tons in 1999, before stabilizing at 50 million tons in 2000-2001 (Table 1). Production of crude steel was slightly under 43 million tons in 1997, but fell 6 percent in 1998 to 40 million tons before gradually recovering to 43-44 million tons in 2000-2001. Thus, the figures in Table 1 indicate that substantial excess capacity still exists.[6] In some contrast, mining and manufacturing survey data on the value of gross output (National Statistical Office various years) and data on producer prices from the Bank of Korea (2003) that are reported in Table 2 suggest that real steel output measured in 1995 won changed very little in 1998, 1999, and 2001 (growth rates of 0-1 percent) and increased a substantial 10 percent in 2000.[7] Although value and quantity estimates also suggest very different growth rates in trade flows, the two sets of estimates concur in suggesting that exports increased rapidly while imports plunged in 1998, and that imports rebounded strongly in 1999 and 2000 while exports fell in 1999 and continued to grow much more slowly than imports in 2000. Correspondingly, apparent consumption also plunged in 1998 and then recovered strongly in 1999 and 2000.

The large differences between quantity and value data partially reflect the effects of the

[4] The pipe and bars sector of Sammi was taken over by POSCO and renamed as Changwon Specialty Steel Co in 1997. INI Steel acquired the other part of Sammi Steel, which was renamed BNG Steel.

[5] POSCO also has a strategic alliance in technology cooperation with China's Bao Steel and Hyundai Hysco has a similar alliance with JFE Group.

[6] However, in a recent publication, the Ministry of Commerce, Industry and Energy (2002) indicated that there are still serious overcapacity problems in the electric furnace and cold rolling facilities and estimated that overcapacity in electric furnace facilities was about 3 million tons.

[7] Measured in current won, the value of gross output grew 13 percent each in 1998 and 2000 but changed little in 1999 and 2001. Finally, measured in current U.S. dollars, gross output decreased 23 percent in 1998 and 12 percent in 2001, but increased 16-19 percent in 1999-2000.

large changes in the value of the won during this period which fell from an average of 804 per U.S. dollar in 1996 to 951 in 1997 and 1,401 in 1998, before rebounding to 1,131-1,189 in 1999-2000, and then falling back to 1,291 in 2001 (International Monetary Fund). As will be analyzed in detail below these changes not only affected the value of output, but had pervasive effects on the Korean economy and cost structures as well. Another important factor is the fact that quantity measures do not reflect the heterogeneity of steel products and the changes in the mix of steel products as well as value measures in many cases. This is most obvious when measures of trade propensities are compared. According to the quantity-based data in Table 1, ratios of both exports and imports to output were generally higher in quantity terms, sometimes much higher (e.g., the export-output ratio in 1998) than in value terms (Table 2). A major reason for this divergence is that quantity data are compiled on a final product basis while production data refer to crude steel production. However, comparisons of these data also suggest that Korea imports and exports products that are generally more expensive per ton than the steel products it produces.

Partially as a result of restructuring efforts described above and the robust recovery of the Korean economy after the crisis in 1999 and 2000, when economic growth exceeded 9 percent annually (Bank of Korea 2003), business conditions improved for Korea's steel industry as illustrated by several indicators in Table 2. First, average labor productivity, measured as value added per employee increased markedly through 1997 and quickly rebounded to 1997 levels after falling in 1998. Second, because the growth of average wages was kept low and employment fell, the share of value added devoted to labor compensation fell markedly. Depreciation expenses also fell. Third, although Korean steel firms maintained relatively healthy operating profits through the crisis, more than 8 percent of sales, and the debt burden was remained relatively mild, the debt burden worsened markedly immediately after the crisis with the total debt/equity ratio and the current debt-equity ratio reaching 265 percent and 142 percent, respectively in 1997. Correspondingly, ratios of operating profits to interest payments (also called the interest coverage ratio) fell to just over 120 percent in 1998 and 1999, and net

profits were zero or negative in 1997-1998 and 2000.[8] Thus non-operating income was strongly negative, and much of this was the result of large debt service payments that took a large portion of operating profits. However, rapid improvements were made and by 2001 the total debt-equity ratio fell below 150 percent, a level comparable to those in more advanced economies such as the European Union, Japan, and the United States. In contrast, the interest coverage ratio remained below 200 percent, which is much lower than common levels in advanced economies (300 percent according to Sim 2000).

3. International Trade and Other External Factors Affecting Demand for Korean Steel

As indicated in the previous section, Korean steel makers are heavily dependent on the domestic market and exports only accounted for one-fourth or less of steel sales in most years in the 1990s (Table 2). However, the export-sales ratio reached 36 percent in 1998 and these export propensities were higher in other post-crisis years, 25-26 percent in 1999-2001, than in the early- to mid-1990s, when they averaged 23 percent and 20 percent respectively. Thus, trends in Korean steel exports tend to be countercyclical to trends in the Korean economy overall, with domestic consumers absorbing relatively large amounts of steel production when Korean growth is rapid and relatively small amounts when growth is slower. This pattern is in part another legacy of Korea's heavy industrialization policies which stressed the role of the steel industry to supply high-quality, low priced intermediate goods to processing industries, which then exported a substantial portion of their output (e.g., shipbuilding, automobiles). Another reason for the large increase in exports in 1998 was buoyant demand in the United States, to which Korean exports almost doubled, but the decline afterwards suggests that most of this increase was the result of excess supply in Korea, not strong U.S. demand. In other words, export markets serve as a buffer for Korean steel makers in times of weak domestic

[8] In manufacturing overall, the situation was much more severe immediately when the crisis hit in 1997 as operating profits fell to 6.1 percent of sales while total debt-equity and current debt-equity ratios skyrocketed to 395 percent and 233 percent, respectively. Correspondingly, net profits were zero or negative in the entire 1997-2001 period and the ratio of operating profits to interest payments fell as low as 68 percent in 1998 and 96 percent in 1999, indicating that operating profits were insufficient to finance debt service (Bank of Korea, various years).

demand.

The export data also indicate that Korea continues to enjoy a substantial revealed comparative advantage in the steel industry in the sense that the ratio of the share of steel in Korean exports to the share of steel in world exports (this ratio is the revealed comparative advantage index in Table 2) vastly exceeded 1 for the entire 1990s. This ratio declined some before the crisis, from 1.9 in 1990-1992 to 1.7 in 1993-1996 and 1.6 in 1997, but rebounded strongly in most years after the crisis, to 2.0 in 1998 and 1.8 in 1999 and 2001. Interestingly, trends in this ratio are similar to trends in steel's share of Korean GDP measured in current prices, which fell from 2.4 percent in 1990-1992 to 1.9 percent in 1997 but then rebounded to 2.1 to 2.3 percent in 1998-2001. Thus, in terms of exports and production, Korea's steel industry appears to have lost a little competitiveness relative to other Korean industries before the crisis, but regained most of the losses after the crisis, suggesting that Korean steel makers have adjusted to the consequences of the crisis relatively successfully.

Another important characteristic of Korea's trade in steel products is the tendency to import intermediate products and export final products. As discussed in the previous section, Korea has relatively large rolling capacity relative to the size of its crude steel capacity and this makes it necessary to import intermediate products used in rolling facilities such as hot coil, bloom, and billets. This is most clearly reflected in Tables 4 and 5, which show that exports primarily consist of universals, plates, and sheets (SITC 674), followed distantly by bars, rods, angles, and shapes (SITC 673) and tubes, pipes, and fittings (SITC 678). In contrast, categories dominated by raw materials and intermediate products such as pig iron and related items (SITC 671) and ingots and primary forms (SITC 672) accounted for much larger shares of imports. Universals, plates, and sheets were also the largest category of imports overall, although a large portion of these imports consisted of hot coil from Japan for use as an intermediate product. In contrast, exports of these goods were more heavily dominated by final rolled products, with the largest share of these exports also going back to Japan through the 1997 and China becoming the largest market in subsequent years. Thus, there is a large amount of horizontal trade between Japan and Korea in these products, though the nature of

imports and exports still tend to differ.

Japan has been the largest source of steel imports in Korea, and its share of the total gradually increased in the late 1990s to over 50 percent in 1999-2001 (Table 5). The largest category of imports from Japan was universals, plates, and sheets, followed by bars, rods, angles, and shapes in most years, and then tubes, pipes, and fittings. On the export side, Japan was also the largest market overall until 1997, the United States became the largest market for one year in 1998, and China became the largest market thereafter (Table 4). Universals, plates, and sheets are the largest category of exports to all of these partners, but exports of tubes, pipes, and fittings were also relatively large to the U.S. market. Although the United States became the largest export market in 1998 and U.S. anti-dumping actions against Korean steel exporters have attracted a lot of attention in Korea, it is important to note that the U.S. share of Korea's exports was only 19 percent in 1998, and lower in other years, averaging 16 percent in 1990-1992 and 1999-2001 and only 12 percent in 1993-1997.

4. Interactions among Domestic Steel Demand, Macroeconomic Variables, and the Exchange Rate

After the crisis the weak won played an important role in the recovery of domestic steel demand by stimulating major export industries such as shipbuilding, automobiles, and electronics, which use steel as an intermediate good. The won/yen rate is particularly important for Korean exporters in these industries because some of their major competitors are Japanese firms. In the years before the crisis the yen/won rate averaged a little less than 8 (7.9 in 1994, 8.2 in 1995, 7.4 in 1996, and 7.9 in 1997; International Monetary Fund 2003) but the won depreciated to between 10.4 and 10.7 won per yen in 1998-2001. This depreciation provided many Korean manufacturers with a competitive advantage over their Japanese competitors and an opportunity to expand their market share. This was true both in the steel industry itself and in other Korean industries which consume Korean steel.

This section tries to analyze some of the benefits accruing from the depreciation of the

won by using a simple simultaneous equation model to analyze the domestic steel demand after the crisis. The model consists of equations explaining how steel demand is related to macroeconomic variables and equations or identities that explain interactions among the macroeconomic variables. The data used in the model cover the period from the first quarter of 1980 to the second quarter of 2001. Macroeconomic variables such as GDP, investment, consumption, exports, imports, M3, and the yield of 3-year corporate bonds are collected from the Bank of Korea (2003). Macroeconomic variables such as GDP, investment, consumption, exports and imports are measured in constant prices of 1995. Consumer prices and the manufacturing capacity utilization ratio are from the National Statistical Office (2003) while exchange rates and world trade volumes are taken from the International Monetary Fund (2003).[9] Domestic steel demand is defined as the apparent consumption (production plus imports less exports) of long steel products and flat steel products and is taken from the Korea Iron and Steel Association (2002).[10]

The model contains 10 behavioral equations that were estimated econometrically and 4 identities, which are detailed in Table 6 and the Appendix.[11] Because quarterly data exhibits strong seasonal trends, three dummies for quarters 1, 2, and 3 were used in all behavioral equations to remove the seasonality (e.g., quarter 4 is the reference period). In addition, because all behavioral equations showed indications of first-order autocorrelation as indicated by the Durbin-Watson statistic, the equations were estimated using the Cochrane-Orcutt method, which is a type of generalized least squares (GLS) estimator that corrects for this problem. In the one case in which this approach did not result in a satisfactory Durbin-Watson statistic, the equation was reestimated in first differences (e.g., the consumer price equation 8) and this appeared to solve the problem. Estimating this model with this simple GLS methodology has three important statistical weaknesses, however. First, there is a high probability that several of the series in the model might not be stationary, in which case the GLS results could be

[9] World trade volume = ((world export/world export unit value) + (world export/world export unit value))/2

[10] Korea Iron and Steel Association(KOSA) does not officially report quarterly steel data. The data whose origin is KOSA has been accumulated by Posco Reaserch Institute. Castings & Forgings are included in flat product for convenience of analysis.

[11] AREMOS 5.3 was employed to do the econometric analysis.

spurious.[12] Unfortunately, the statistical tests for this problem and methods of dealing with it are only valid in samples much larger than the sample available here and it is very difficult to deal with this problem in the context of a simultaneous equation system. There is thus no practical way around assuming stationarity in this case. Second, simultaneity problems may result in the GLS estimates being inconsistent, or in other words biased and inefficient even in large samples. It would thus be preferable to use instrumental variable estimator or another estimator that avoids this problem, but this proved to be impossible to find a set of viable instruments in this case.[13]

Although some of the sections and wire rods included in long steel products are used for shipbuilding and automobiles, the vast majority of long products are used for construction materials (e.g., reinforcing bars). Therefore, apparent consumption of long products is explained by investment in building construction and investment in other construction (Table 6). In contrast, flat products are used in a wide variety of goods and therefore investment in machinery (including equipment), private consumption of durable goods, and exports (which are primarily manufactures) are employed as explanatory variables in this case. It should be noted that the automobile industry is a major consumer of flat products and that investment in machinery includes automobiles purchased by corporations while consumption of durables includes automobiles purchase by households, and automobiles also account for a substantial portion of exports. Similar points can be made about investment in and exports of electronic machinery and ships, as well as consumption of electronic machinery. These industries consume flat products such as cold rolled steel, galvanized sheets, and plates.[14]

In the macroeconomic part of the model, investment in construction of buildings is determined by investment in machinery and the real money supply (defined as M3 divided by

[12] For example, the difficulties encountered in the consumer price equation (8) suggest that non-stationarity may be a problem in this equation and this is one reason the equation was reestimated in first differences.

[13] A large number of macroeconometric models are estimated with OLS for this reason and because simultaneity biases are often thought to be relatively small in such models.

[14] Despite attempts to include it, the price variable does not significantly affect steel demand in Korea during this period, probably for two reasons. First, this is a national model with little role for relative prices such as the price of domestic product relative to imported product. Second, there is no strong evidence that Korean steel consumers adjust quantity of production significantly or substitute other materials for steel in response to changes in steel prices.

consumer price level, Table 6). Investment in machinery is explained by the manufacturing capacity utilization ratio and the sum of private consumption, exports, and investment in other construction. Investment in other construction, which is mainly government investment, is an exogenous variable. Private consumption is then explained by the unemployment rate, GDP (a proxy for total income), and in the case of nondurables, the real money supply. Exports are determined by the volume of world trade and won and yen exchange rates while imports are a function of the won exchange rate, exports, and the sum of private consumption and investment in machinery. Finally, consumer prices are determined by the won exchange rate and the real money supply while unemployment is explained by investment and the level of consumer prices. Some additional dummy variables are employed to account for outliers, many of which resulted from large fluctuations in several endogenous variables after the crisis that could not be fully explained by variation in explanatory variables included.

The model is then used to simulate domestic steel demand under different assumptions about the exchange rate. Scenario I assumes that the won/dollar rate was equivalent to the annual average for 1997, 951, for the first quarter of 1998 through the second quarter of 2001. Scenario II then makes the same assumption about the won/dollar rate as scenario I and adds the assumption that won/yen rate was also equivalent to the 1997 average, 7.86, for this period.[15] In other words, scenario I examines what would have happened if the won had not depreciated after the crisis and scenario II asks what would have happened if the won had not depreciated and fluctuations in the yen/dollar rate had not occurred, thereby eliminating any substitution effect between Korean and Japanese exports.

As Table 7 shows, apparent consumption of steel would have been less than actual apparent consumption under both of these scenarios. Under scenario I domestic steel demand would have been 5.9 percent lower than the actual demand in 1998, 4.6 percent lower in 1999, and 3.9 percent lower in 2000. Under scenario II the initial decrease would have been smaller than in scenario I, 5.0 percent in 1998, but subsequent declines would have been larger, 5.2 percent in 1999, and 5.8 percent in 2000, largely because the yen was cheaper in 1998 (131

[15] Equivalently, the yen/dollar rate was set at 121 in scenario II.

yen/dollar) than the assumed value in the scenario (121 yen/dollar) but more expensive than the assumed rate in 1999 and 2000 (114 and 108 yen/dollar, respectively; International Monetary Fund 2003). Most of the decline in steel demand resulted from declines in demand for flat products, which fell 10.3 percent in 1998, 7.5 percent in 1999, and 6.1 percent in 2000 under scenario 1 and 8.8 percent, 8.5 percent, 8.9 percent, respectively, under scenario 2. The declines in flat product consumption largely result from declines in exports under both scenarios, which directly affect the demand for flat products, reflecting the large role of exporting industries such as automobiles, shipbuilding, and electronics as consumers of flat products. Relatively large declines in machinery investment and GDP (which in turn reduced private consumption of durables) also contributed to the fall in the demand for flat products. In contrast, the demand for long steel products was largely unaffected in both scenarios primarily because construction investment declined relatively little, especially in 1998 and 1999.

In one important respect, these simulations are not very realistic. Namely, if one views the fall of the won as a cause of the crisis, then one might expect GDP to be higher than actual values, not lower, if the won did not depreciate. Even if one views the fall of the won as a symptom of problems that led to the crisis and subsequent contraction of the economy in 1998, it may not seem realistic to postulate that a more expensive won could have accompanied growth below actual levels in post-crisis Korea. In this context, it is important to emphasize that this simple model does not describe the complex causes of the won depreciation (exchange rates are exogenous) or the crisis itself. Rather the model only describes how the adjustment process would have differed after the crisis if the won had not depreciated as much as it actually did. In this respect, the simulations clearly indicate that the depreciation of the won facilitated the Korean economy adjust to the post-crisis environment, thereby helping to stimulate Korea's domestic steel demand.

5. Conclusion

This paper first analyzed the major trends in Korea's steel industry in the 1990s, highlighting the prominent role of overcapacity in the industry. Overcapacity resulted both from chronic overinvestment in past years and the collapse of domestic demand following the economic crisis, which led to a large depreciation of the won in December 1997 followed by a large economic contraction in 1998. After the crisis a number of Korean firms, including a few medium-sized steel firms, became insolvent and had to cease operations, while other firms suspended or cancelled planned investments. Steel firms also began to downsize, reducing employment substantially in 1997-1998, and it seems clear that the days of rapid growth in this industry are over in Korea. The crisis also led to large policy changes, including the accelerated privatization of the largest steel firm, POSCO, which was previously state-owned. The paper then analyzed the role of international trade in Korean steel, highlighting its relatively small size in most years and the important role the large increase of exports played in 1998 as a buffer for Korean steel makers in the midst of the crisis. Finally, the paper used a simple model of interactions between domestic steel demand and macroeconomic variables to illustrate how exchange rate adjustments played a particularly important role in the recovery of Korea's steel industry after the crisis.

In many respects, it thus appears that Korean steel makers have adjusted to the effects of the crisis relatively successfully. However, there are still a number of problems that remain for Korean steel makers. First and foremost, there are still important overcapacity problems with regard to rolling facilities and electric arc furnaces that need to be resolved. Second, the financial condition of Korean corporations, including a number of steel firms, still do not meet the accepted standards of advanced countries and further debt reduction efforts are thus necessary. Third, there is a danger that Korea's steel makers will overestimate the scope of their recovery because of unusually favorable changes in the economic environment such as the depreciation of the won. Fourth, Korea's steel firms are likely to gradually loose their competitiveness to new competitors with lower costs in a number of products, much as Japanese

firms lost some of their competitive advantages to Korean steel makers in the past two decades. Thus, Korea's steel firms will have to continue with vigorous restructuring efforts, including capacity reduction and debt reduction, if they are to successfully maintain and strengthen their competitiveness.

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Table 1: Production, Apparent Consumption, Trade, and Capacity in Korea's Steel Industry (million metric tons)

Indicator	1990-1992	1993-1996	1997	1998	1999	2000	2001
Production, Apparent Consumption, and Trade							
Production of crude steel	25.73	32.75	42.55	39.90	41.04	43.11	43.85
Apparent consumption							
Crude steel estimate	24.65	30.82	39.90	26.02	35.46	40.00	na
Finished steel estimate	23.14	29.19	38.15	25.01	34.04	38.50	38.30
Calculated	25.00	31.13	40.70	25.13	36.23	40.71	40.55
Exports, finished & semi-finished	9.39	10.02	11.29	18.38	13.69	13.85	14.04
Imports, finished & semi-finished	7.36	8.40	9.44	3.61	8.88	11.45	10.74
Capacity							
Total capacity	27.83	37.70	43.35	45.09	48.66	49.66	49.89
Basic oxygen furnace	18.40	21.15	21.15	22.01	26.18	26.18	26.18
Electric arc furnace	9.44	16.54	22.20	23.09	22.48	23.48	23.71

Source: International Iron and Steel Institute (various years); Korean Iron and Steel Association (2002, 2003).

Table 3: Reductions in Steel Production or Planned Steel Production after the Crisis (thousand metric tons)

	Amount of Steel Production Affected						
		Finished Steel					
Company	Crude steel	Hot-rolled	Cold-rolled	R-bars, bars	Plate	Sections	Pipes & tubes
Total	11,260	6,800	2,180	2,088	410	416	757
Construction abandonded	8,000	5,000	2,000	-	-	-	-
Hanbo Steel	6,000	3,000	2,000	-	-	-	-
POSCO	2,000	2,000	-	-	-	-	-
Operations suspended	2,000	1,800	-	750	-	-	-
Hanbo Steel	2,000	1,800	-	-	-	-	-
Others	-	-	-	750	-	-	-
Factories closed	1,260	-	180	1,338	410	416	757
Dongkook Steel	1,060	-	-	858	200	316	-
Seoul	200	-	-	130	-	100	-
Others	-	-	180	350	210	-	757

Source: *Korea Metal Journal* .

Table 2: Basic Indicators for Korea's Steel Industry

Indicator	1990-1992	1993-1996	1997	1998	1999	2000	2001
Production, Employment, and Related Indicators (plant-based compilations), NSO manufacturing surveys							
Gross output, billion US$	18.346	26.314	27.564	21.137	24.609	29.245	25.737
Trillion current won	13.604	20.907	26.221	29.623	29.256	33.075	33.226
Trillion 1995 won	14.909	21.470	25.077	25.202	25.498	28.279	28.696
Value added, billion US$	6.847	9.368	9.217	7.391	8.681	9.456	8.802
Trillion current won	5.083	7.441	8.768	10.358	10.321	10.694	11.363
- % of GDP	2.38	2.13	1.93	2.33	2.14	2.05	2.06
Trillion 1995 won	5.567	7.641	8.385	8.812	8.995	9.144	9.813
- % of GDP	1.95	2.11	1.98	2.23	2.06	1.91	1.99
Employment, number	77,959	74,950	70,683	64,869	67,306	64,823	64,347
- % of total	0.42	0.37	0.33	0.32	0.33	0.31	0.30
Value Added/Employee, US$	89,219	124,831	130,394	113,935	128,983	145,876	136,783
Thousand current won	66,423	99,176	124,042	159,673	153,338	164,980	176,586
Thousand 1995 won	72,644	101,877	118,631	135,841	133,643	141,058	152,506
Compensation/Employee, US$	15,487	20,779	21,017	13,750	16,273	20,033	19,640
Thousand current won	11,507	16,520	19,994	19,270	19,346	22,656	25,355
Shares of Value Added in Percent							
Wages & salaries	17.42	16.65	16.12	12.07	12.62	13.73	14.36
Depreciation	32.59	24.16	19.79	16.34	18.86	19.93	20.33
Profit & taxes	49.99	59.19	64.09	71.59	68.53	66.34	65.31
Financial Indicators (firm-based compilations) and Prices, Bank of Korea							
Operating profits/sales, %	6.58	8.77	9.39	8.60	8.74	10.00	8.47
Operating profits/interest payments, %	119.02	150.41	145.61	125.20	121.32	190.10	180.28
Net profits/sales, %	1.80	3.24	-1.02	0.08	10.60	-5.59	3.32
Total debt/equity, %	171.40	193.58	265.17	203.39	193.31	183.81	147.43
Current debt/equtiy, %	84.87	108.40	142.37	99.68	67.92	78.57	57.96
Producer prices 1995=100	91.15	97.02	104.56	117.54	114.74	116.96	115.79
Export prices 1995=100	85.63	95.64	107.73	141.66	110.68	112.47	115.25
Import prices 1995=100	87.02	94.78	105.96	143.60	108.87	113.22	136.45
Trade, (US$ estimates from Statistics Canada, export prices from Bank of Korea, exchange rate from IMF)							
Exports, billion current US$	4.238	5.259	5.995	7.557	6.329	7.207	6.459
- % of Gross Output	23.10	19.99	21.75	35.75	25.72	24.64	25.10
Trillion current won	3.151	4.181	5.703	10.591	7.524	8.151	8.339
Trillion 1995 won	3.673	4.372	5.294	7.476	6.798	7.247	7.235
Revealed comparative advantage index	1.94	1.69	1.59	1.96	1.83	1.71	1.80
Imports, billion current US$	3.174	4.917	5.394	2.543	3.828	5.150	4.190
- % of Gross Output	17.30	18.69	19.57	12.03	15.56	17.61	16.28
Trillion current won	2.351	4.413	5.131	3.564	4.551	5.824	5.409
Trillion 1995 won	2.699	4.560	4.843	2.482	4.180	5.144	3.964
Implied Apparent Consumption (=Output-Exports+Imports)							
Billion current US$	17.282	25.973	26.963	16.123	22.108	27.188	23.468
Trillion current won	12.805	21.139	25.650	22.596	26.282	30.749	30.297
Trillion 1995 won	13.935	21.658	24.626	20.207	22.881	26.177	25.425

Sources: Bank of Korea (2003, various years); International Monetary Fund (2003); National Statistical Office (2003, various years); Statistics Canada (various years).

Table 4: The Value of Korea's Steel Exports by Commodity and Destination (US$ millions)

Indicator	1990-1992	1993-1996	1997	1998	1999	2000	2001
All Steel (SITC 67)	4,238	5,259	5,995	7,557	6,329	7,207	6,459
Asia	3,166	4,366	4,836	4,684	4,352	4,861	4,479
China	318	875	1,003	1,124	1,334	1,648	1,671
Japan	1,495	1,557	1,521	1,155	1,101	1,291	921
Taiwan	201	256	224	336	264	235	201
Europe	138	80	118	858	374	543	403
North America	724	654	834	1,674	1,272	1,495	1,226
U.S.A.	675	602	744	1,412	1,059	1,146	1,007
Pig iron, sponge iron, etc. (SITC 671)	2	7	23	27	21	34	28
Asia	2	6	22	19	15	25	23
China	0	2	2	2	2	2	3
Japan	1	2	14	10	5	11	10
Taiwan	0	0	4	5	4	3	4
Europe	0	0	1	0	0	2	1
North America	0	0	0	8	5	7	3
U.S.A.	0	0	0	8	5	7	2
Ingots, primary forms, etc. (SITC 672)	105	91	183	141	51	34	88
Asia	98	85	146	103	27	16	84
China	23	14	2	15	11	9	75
Japan	44	38	57	5	1	2	5
Taiwan	8	13	21	44	10	3	1
Europe	5	0	0	12	13	7	0
North America	2	6	38	26	11	10	3
U.S.A.	2	6	38	26	10	2	3
Bars, rods, angles, shapes (SITC 673)	478	643	559	1,058	799	782	670
Asia	414	559	443	518	415	416	414
China	83	175	65	132	72	65	69
Japan	139	100	60	53	54	61	52
Taiwan	61	55	38	55	37	37	27
Europe	20	13	18	82	55	67	62
North America	30	60	84	431	299	273	157
U.S.A.	28	56	80	390	237	167	101
Universals, plates, sheets (SITC 674)	2,842	3,577	4,067	5,129	4,351	5,113	4,443
Asia	2,163	3,101	3,459	3,432	3,274	3,718	3,292
China	200	619	791	897	1,158	1,486	1,430
Japan	1,064	1,164	1,135	882	829	983	638
Taiwan	114	163	138	193	172	146	124
Europe	90	39	46	681	233	388	264
North America	445	347	430	793	630	792	657
U.S.A.	414	316	370	628	531	616	539
Tubes, pipes, fittings (SITC 678)	530	571	708	763	659	742	736
Asia	294	345	456	330	323	350	334
China	4	35	105	31	32	22	24
Japan	152	131	117	80	83	99	82
Taiwan	5	10	9	22	24	25	14
Europe	8	5	13	35	28	26	26
North America	196	185	203	326	243	317	314
U.S.A.	190	177	188	282	200	276	285

Source: Statistics Canada (2003).

Table 5: The Value of Korea's Steel Imports by Commodity and Source (US$ millions)

Indicator	1990-1992	1993-1996	1997	1998	1999	2000	2001
All Steel (SITC 67)	3,174	4,917	5,394	2,543	3,828	5,150	4,190
Asia	1,908	2,894	3,830	1,809	2,710	3,767	3,083
China	143	697	1,455	431	517	861	517
Japan	1,410	1,886	2,115	1,235	1,982	2,658	2,374
Taiwan	63	64	70	30	90	129	81
Europe	385	640	436	230	230	285	307
North America	324	254	224	120	131	146	90
U.S.A.	226	162	124	71	62	81	74
Pig iron, sponge iron, etc. (SITC 671)	288	706	1,100	730	772	941	690
Asia	112	445	902	597	497	588	393
China	43	275	680	323	243	377	194
Japan	18	71	89	166	171	123	117
Taiwan	3	0	0	0	0	0	6
Europe	27	38	25	19	12	13	13
North America	7	4	8	6	8	8	7
U.S.A.	6	4	8	6	8	8	7
Ingots, primary forms, etc. (SITC 672)	309	829	967	353	485	705	500
Asia	86	288	458	59	140	289	218
China	25	173	341	24	47	178	68
Japan	12	65	97	34	85	108	149
Taiwan	3	3	0	0	0	3	0
Europe	21	60	37	1	23	23	29
North America	22	44	97	58	73	65	16
U.S.A.	13	8	4	10	4	1	1
Bars, rods, angles, shapes (SITC 673)	654	715	604	246	432	566	464
Asia	426	425	420	205	350	438	397
China	38	26	13	2	10	43	47
Japan	209	303	357	191	303	350	315
Taiwan	8	22	28	12	26	33	26
Europe	122	120	82	26	34	44	33
North America	29	15	13	8	9	19	10
U.S.A.	26	15	13	8	9	19	10
Universals, plates, sheets (SITC 674)	1,549	2,087	2,140	870	1,764	2,449	2,030
Asia	1,033	1,364	1,682	751	1,470	2,128	1,737
China	26	161	325	34	155	179	112
Japan	936	1,151	1,308	699	1,242	1,848	1,564
Taiwan	47	38	40	15	63	91	48
Europe	145	299	163	82	74	85	115
North America	214	114	28	7	8	12	11
U.S.A.	131	64	23	7	8	12	11
Tubes, pipes, fittings (SITC 678)	308	445	413	270	281	364	379
Asia	211	280	261	152	179	229	246
China	5	23	38	23	27	33	37
Japan	203	247	218	126	148	191	198
Taiwan	1	0	0	1	1	1	1
Europe	60	105	105	90	71	98	101
North America	37	55	41	25	29	33	28
U.S.A.	36	51	39	25	28	33	28

Source: Statistics Canada (2003).

Table 6: Macroeconometric Model Specification

Eq.	Endogenous Variables	Explanatory Variables
BEHAVIORIAL EQUATIONS		
1	Consumption of durables (private)	Unemployment rate, GDP, Seasonal dummies
2	Consumption of nondurables (private)	Unemployment rate, GDP, M3/Consumer price level, Seasonal dummies
3	Investment in construction of buildings	Investment in machinery, Money/Consumer price level, Dummy for 1999Q1, Seasonal dummies
4	Investment in machinery (& equipment)	Manufacturing capacity utilization ratio, Consumption (private) + Exports + Investment in construction, Dummy for 1997Q4-1999Q1, Seasonal dummies
5	Exports of goods	2 quarter lagged moving average of won/dollar rate, 2 quarter lagged moving average of yen/dollar rate, World trade volume (index), Dummy for 1999Q1, Seasonal dummies
6	Imports of goods	2 quarter lagged moving average of won/dollar rate, Consumption (private) + Investment in machinery, Exports, Seasonal dummies
7	Unemployment rate	Investment in construction + Investment in machinery, Consumer price level, Dummy for 1998Q2-1999Q3, Seasonal dummies
8	First difference of consumer price levels	First difference of the won/dollar rate, First difference of the 2 quarter lagged moving average of the M3/GDP ratio, Dummy for 1995Q1, Seasonal dummies
9	Consumption of flat steel products (apparent)	Investmemt in machinery, Consumption of durables (private), Exports, Dummy for 1998Q1-1999Q1, Seasonal dummies
10	Consumption of long steel products (apparent)	Investment in construction of buildings, Investment in construction of other items, Dummy for 1998Q1-1999Q1, Seasonal dummies
IDENTITIES		
11	Consumption (private) = Consumption of durables (private) + Consumption of nondurables (private)	
12	Investment in construction = Investment in construction of buildings + Investment in construction of other items	
13	GDP = Consumption (private) + Consumption (government) + Investment in construction + Investment in machinery + Investment in inventories + exports (of goods) + exports of services - imports of goods - imports of services	
14	Consumption of steel = Consumption of long steel products + Consumption of flat steel products	

Table 7: Results of Simulating Domestic Steel Demand with Alternative Exchange Rates (percentage differences between simulated and actual values)

	Apparent Consumption of Steel			Major Macroeconomic Variables			
Year, Quarter	All products	Flat products	Long products	GDP	Investment in machinery	Investment in con-struction	Exports
Scenario I: Won/Dollar=951.29 (average for 1997) for 1998Q1-2001Q2							
1998Q1	-4.57	-7.92	-0.89	-7.17	-5.29	-1.36	-11.92
1998Q2	-7.72	-13.82	-2.05	-12.00	-9.29	-2.59	-19.16
1998Q3	-6.09	-10.70	-1.55	-9.11	-7.08	-1.89	-15.38
1998Q4	-4.94	-8.84	-1.25	-7.16	-5.87	-1.30	-13.65
1998	-5.85	-10.30	-1.46	-8.85	-6.90	-1.80	-15.13
1999Q1	-5.17	-8.64	-1.29	-7.47	-5.84	-1.68	-11.58
1999Q2	-4.30	-7.39	-1.09	-6.39	-5.03	-1.20	-10.06
1999Q3	-4.61	-7.35	-1.09	-6.34	-5.05	-1.22	-10.02
1999Q4	-4.42	-6.95	-1.05	-5.79	-4.84	-1.04	-9.71
1999	-4.61	-7.53	-1.13	-6.44	-5.16	-1.25	-10.28
2000Q1	-4.42	-6.86	-1.05	-6.13	-4.72	-1.49	-8.44
2000Q2	-3.68	-5.90	-0.91	-5.26	-4.10	-1.08	-7.37
2000Q3	-3.71	-5.66	-0.87	-4.99	-3.96	-1.03	-7.18
2000Q4	-4.01	-6.13	-0.92	-5.30	-4.35	-0.96	-8.15
2000	-3.94	-6.12	-0.94	-5.39	-4.28	-1.11	-7.77
2001Q1	-5.69	-8.82	-1.31	-8.01	-6.14	-1.84	-10.94
2001Q2	-6.53	-10.48	-1.60	-9.40	-7.34	-1.91	-13.21
Scenario II: Won/Dollar=951.29 & Won/Yen=7.8619 (average for 1997) for 1998Q1-2001Q2							
1998Q1	-4.22	-7.34	-0.79	-6.79	-4.87	-1.20	-11.01
1998Q2	-6.78	-12.20	-1.75	-10.96	-8.11	-2.21	-16.58
1998Q3	-4.62	-8.18	-1.10	-7.50	-5.29	-1.34	-11.27
1998Q4	-4.17	-7.52	-1.01	-6.38	-4.92	-1.05	-11.39
1998	-4.96	-8.80	-1.18	-7.89	-5.82	-1.45	-12.64
1999Q1	-5.45	-9.10	-1.37	-7.77	-6.18	-1.78	-12.33
1999Q2	-4.53	-7.78	-1.17	-6.64	-5.32	-1.28	-10.67
1999Q3	-5.03	-8.00	-1.21	-6.75	-5.53	-1.35	-11.03
1999Q4	-5.78	-9.04	-1.44	-7.09	-6.43	-1.43	-13.04
1999	-5.20	-8.48	-1.29	-7.04	-5.87	-1.43	-11.79
2000Q1	-6.38	-9.84	-1.62	-8.14	-6.97	-2.28	-12.79
2000Q2	-5.47	-8.71	-1.44	-7.14	-6.23	-1.72	-11.46
2000Q3	-5.57	-8.43	-1.40	-6.87	-6.06	-1.65	-11.20
2000Q4	-5.61	-8.51	-1.38	-6.85	-6.17	-1.44	-11.65
2000	-5.75	-8.86	-1.46	-7.21	-6.35	-1.73	-11.74
2001Q1	-6.59	-10.18	-1.58	-8.93	-7.17	-2.21	-12.86
2001Q2	-6.61	-10.61	-1.63	-9.48	-7.44	-1.94	-13.38

Appendix: Details of the Modeling Interaction among Domestic Steel Demand, Macroeconomic Variables, and the Exchange Rate

This appendix provides additional details on the model of interaction among domestic steel demand, macroeconomic variables, and the exchange rate. Specifically, Appendix Table 1 details variable definitions, Appendix Table 2 provides details on identities and estimated equations (t-statistics are given in parentheses), and the Appendix Figures show results of historical simulation for major variables.

Appendix Table 1: Variable Definitions

	Name	Economic Variables	Unit
ENDOGENOUS	CPI	Consumer price index	Index 1995=100
	CSM	Consumption, private	Billion won at 1995 prices
	CSMDU	Consumption of durables, private	Billion won at 1995 prices
	CSMX	Consumption of non-durables, private	Billion won at 1995 prices
	CX	Exports of merchandise	Billion won at 1995 prices
	FLAT	Apparent consumption of flat steel products	1,000 Mt
	GDP	Gross domestic products	Billion won at 1995 prices
	IM	Imports of merchandise	Billion won at 1995 prices
	INC	Investment in construction	Billion won at 1995 prices
	INCB	Investment in construction of buildings	Billion won at 1995 prices
	INM	Machinery & equipment investment	Billion won at 1995 prices
	LONG	Apparent consumption of long steel products	1,000 Mt
	STEEL	Apparent consumption of all finished steel	1,000 Mt
	UNEMP	Unemployment rate	Percent
EXOGENOUS	D1	Seasonal dummy for the 1st quarter	
	D2	Seasonal dummy for the 2nd quarter	
	D3	Seasonal dummy for the 3rd quarter	
	EXS	Export of services	Billion won at 1995 prices
	GOV	Government consumption	Billion won at 1995 prices
	IMS	Import of services	Billion won at 1995 prices
	INCS	Investment in construction of other items	Billion won at 1995 prices
	INVT	Inventory changes	Billion won at 1995 prices
	M3	Money supply (M3)	Billion won
	STER	Statistical discrepancy	Billion won at 1995 prices
	TRADE	Volume of world trade	Index
	UTIL	Manufacturing capacity utilization ratio	Percent
	Won	Won/dollar	Won
	Yen	Yen/dollar	Yen

* Dummy variables for other periods are not listed here but are indicated in equations in Appendix Table 2 with D(XXXX,X–YYYY,Y) where a dummy equals 1 for quarter X of year XXXX to quarter Y of year YYYY.

Appendix Table 2: Estimated Equations & Identities

Part A: Identities

CSM = CSMX + CSMDU

INC = INCB + INCS

GDP = CSM + GOV + INC + INM + INVT + EX + EXS – IM – IMS + STER

STEEL = LONG + FLAT

Part B: Estimated Equations

1) log CSMDU

= 7.51103 * log (100 – UNEMP) + 1.81690 * log GDP + 0.50317 * D1

(4.83210) (33.1018) (13.9747)

+ 0.42811 * D2 + 0.26948 * D3 – 47.1861

(12.7522) (8.95805) (6.62362)

R^2 = 0.9835 D-W (1) = 2.1775

AR_0 = 0.45817 * AR_1

(3.95428)

2) log CSMX

= 0.19653 * log (100 – UNEMP) + 0.35518 * log GDP

(0.76544) (8.88173)

+ 0.25006 * log (M3/CPI) + 0.03587 * D1 – 0.00579 * D2

(11.2000) (3.93838) (0.89674)

+ 0.01842 * D3 + 3.61378

(3.29265) (3.19943)

R^2 = 0.9987 D-W (1) = 2.0994

AR_0 = 0.84427 * AR_1

(13.7434)

Appendix Table 2 (continued)

3) log INCB

= 0.53780 * log INM + 0.22980 * log (M3/CPI)
(4.15375) (2.49196)

– 0.37959 * D(1999,1) – 0.07075 * D1 + 0.07909 * D2
(3.74640) (2.76376) (2.70339)

+ 0.08548 * D3 + 2.31226
(3.35596) (3.51210)

R^2 = 0.9629 D-W (1) = 1.9573

AR_0 = 0.69800 * AR_1
(7.83025)

4) log INM

= 0.91635 * log UTIL + 0.95810 * log (CSM + EX + INC)
(3.70749) (6.91760)

– 0.18775 * D(1997,4-1999,1) + 0.07156 * D1
(3.75934) (3.22378)

+ 0.06090 * D2 – 0.02373 * D3 – 5.62875
(3.35572) (1.46816) (2.99782)

R^2 = 0.9791 D-W (1) = 2.3894

AR_0 = 0.84553 * AR_1
(12.0056)

Appendix Table 2 (continued)

5) log EX

= 0.46683 * log (movavg(2,Won)) – 0.36314 * log (movavg(2,Yen))
(3.70715) (–3.19284)

+ 1.34801 * log TRADE + 0.25726 * D(1999,1) – 0.06336 * D1
(11.7212) (5.28334) (–4.34418)

– 0.00147 * D2 + 0.04169 * D3 – 1.91779
(–0.10282) (3.06573) (1.80345)

R^2 = 0.9951 D-W (1) = 2.1284

AR_0 = 0.71215 * AR_1
(9.5955)

6) log IM

= – 0.33181 * log (movavg(2,won)) + 0.96493 * log (CSM + INM)
(–3.28445) (8.84075)

+ 0.38053 * log EX + 0.06654 * D1 + 0.07246 * D2 + 0.00543 * D3
(4.92843) (5.63284) (6.12753) (0.52760)

– 2.24467
(–2.27169)

R^2 = 0.9960 D-W (1) = 1.9790

AR_0 = 0.58303 * AR_1
(5.93827)

Appendix Table 2 (continued)

7) log (100 – UNEMP)

= 0.05102 * log (INC + INM) – 0.07869 * log CPI
(7.91508) (–6.72393)

– 0.01778 * D(1998,2-1999,3) + 0.00249 * D1
(–4.58113) (1.20927)

+ 0.00217 * D2 + 0.00454 * D3 + 4.40781
(1.73384) (3.87677) (146.490)

R^2 = 0.9114 D-W (1) = 2.2380

AR_0 = 0.67713 * AR_1
(8.63400)

8) dlog CPI

= 0.07987 * dlog (Won) + 0.10572 * dlog (movavg(2,M3/GDP))
(5.63662) (2.28206)

– 0.00551 * D(1995,1) + 0.00184 * D1 + 0.00016 * D2
(–2.73656) (0.36127) (0.03059)

+ 0.00362 * D3 + 0.01079
(1.43845) (5.35684)

R^2 = 0.6640 D-W (1) = 2.1595

Appendix Table 2 (continued)

9) log FLAT

= 0.41393 * log INM + 0.25373 * log CSMDU + 0.22386 * log EX
(3.36345) (2.36786) (3.49689)

– 0.17206 * D(1998,1-1999,1) + 0.00921 * D1
(2.51108) (0.37974)

– 0.07564 * D2 + 0.00620 * D3 + 0.02850
(–2.65221) (0.24455) (0.05984)

R^2 = 0.9763 D-W (1) = 1.8455

AR_0 = 0.43511 * AR_1
(3.74434)

10) log LONG

= 0.43265 * log INCB + 0.73652 * log INCS
(7.46952) (13.7709)

– 0.26272 * D(1998,1-1999,1) + 0.59829 * D1
(–4.25539) (12.3220)

+ 0.21437 * D2 + 0.12277 * D3 – 2.58418
(6.59385) (4.28176) (–7.02489)

R^2 = 0.9714 D-W (1) = 2.0746

AR_0 = 0.35639 * AR_1
(2.95948)

Appendix Figures: Historical Simulation (1998 1q – 2001 2q)