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*Michał Przybyliński**

IMPORT SHARE EQUATIONS FOR IMPEC

I. INTRODUCTION

Import equations in Polish model IMPEC, like in most of INFORUM models, explain the ratio of import to total output. That is why, the product classification of import data must be the same as in the model, that means NACE. We can not use SITC or Polish CN data on imports simply because they don't fit to the data on output. At the moment, our data set in 57 NACE classification, covers 5 years, and these data are expressed only in current prices, with no information about price deflators. The most detailed time series we can collect now include 10 categories according to NACE. The data cover the period 1984–2001.

The previous version of import share equations (Przybylinski 1998) was very modest, as the commodities were divided into three groups only.

Practically, there is no information available on import of services. It might be calculated by subtracting commodity import from import in National Accounts, but even this operation is not precise – sometimes we get negative values.

For the purposes of IMPEC two sets of equations were estimated. The first set of symptomatic (time trend) equations shows the patterns of transition in each group of commodities. The main idea here is to show the expected growth in import shares, due to opening the economy. Another set of equations uses some explanatory variables. It should serve for simulations, where changes in prices or exchange rates are considered.

II. TRANSITION CURVE

The opening of Polish foreign trade started in 1990, although some steps towards it can be seen in late eighties. Soon after the fall of the centrally planned economy and COMECON, regulations in Polish foreign trade gradually changed towards the future joining the EU. Until 2001 the volume, as well as value calculated in USD of commodity imports increased more than five times comparing to 1990. According to National Accounts, the volume of imports of goods and services increased by over four times.

* Chair of Theory and Analyses of Economic Systems, University of Łódź

Similar tendencies are shown in export, but the rise is not so high. The changes in relative prices of export has been more dynamic, so we can see that the share of export in GDP has risen significantly in the nineties, only if we calculate it in constant prices. This share in current prices seems rather stable.

Apart from the changes in regulations towards free market and opening of the economy, there is probably another tendency hidden here, which has more universal roots. This is the global tendency to increase the trade turnover caused by more effective means of communications and transportation etc. All these reasons make the import shares grow very quickly.

These tendencies were analyzed carefully. Recently, the scientific output has been concentrated on estimating or predicting the effects of accession. Apart from purely qualitative elaborations, most papers discuss theoretical models with the support of statistical evidence (e.g. Wysokinska and Witkowska 2004, Czarny and Lang 2002, Cieslik 2001, Misala 1999). Calculations based on empirical data usually verify theories of international trade by means of estimating shifts in factor contents of trade, or calculating intra-industry trade indices.

Looking at the graphs showing the import share in total output (Fig. 1–11) we can see a general rule: comparing with the '80s, these shares measured both in constant and current prices have risen dramatically. For all commodities, the import share reached 0.28 in 2001 starting from less than 0.1 in 1990. After eleven years, transition process seems to be over for agricultural products, other non metallic products, and other commodities. Import shares for other categories are still growing. It is hard to decompose this growth according to the reasons mentioned above, but altogether these tendencies shape the import shares time series into logistic time trend functions:

$$y = d + \frac{a - d}{1 + be^{-ct}} \tag{1}$$

where the initial value, $d + (a - d)/(1 + b)$ is the share of imports typical for the old style economy and the saturation level a is the share typical for a free market economy.

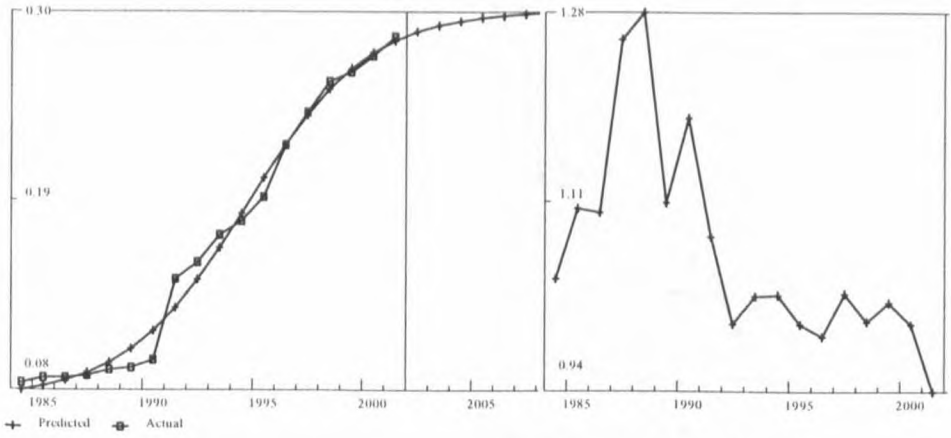
As it can be seen, dummy variables were introduced in some cases, especially for 1990 and 1991, when the market changed its rules and sometimes we witnessed price revolutions. Introduction of such variables changes the shape of the trend function and sometimes we have alternatives like on Figure 9, but the concept of logistic function seems to be right. The same applies to the shares measured in current prices. There is one exception – products of mining quarrying, fuels and energy, where we can see that the share in current prices, after some perturbations, came back to the level of 1985. In the right column of

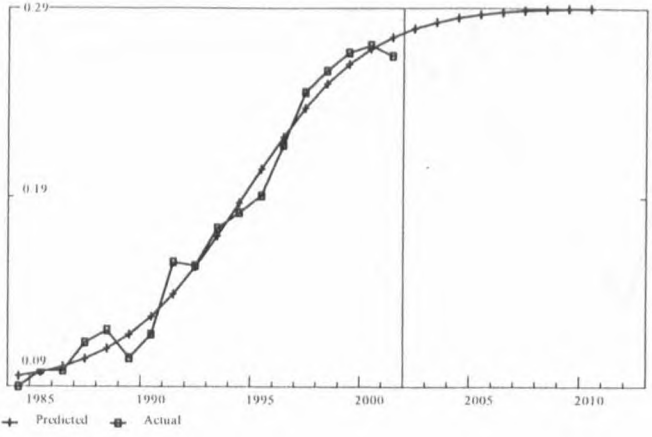
graphs there are ratios of import prices to domestic prices (index, which value in 2000 is 1). There is no common tendency here. In five cases (which is exactly a half) we may say that the price ratios after long and dramatic journey came back more or less to their initial levels. For mining and other non-metallic products these ratios went down, and for metals, machinery and textiles they went up. These three cases show, that there exist reasons for opening the economy which are so strong, that even unfavorable changes in prices don't compensate them.

Looking at the graphs we can see different speed of transition processes. In some cases the transition seem to be over (agriculture, other non metallic mineral products) in some other cases it looks like it would continue for some years (food products). Generally we can say, that the main wave of changes is behind us.

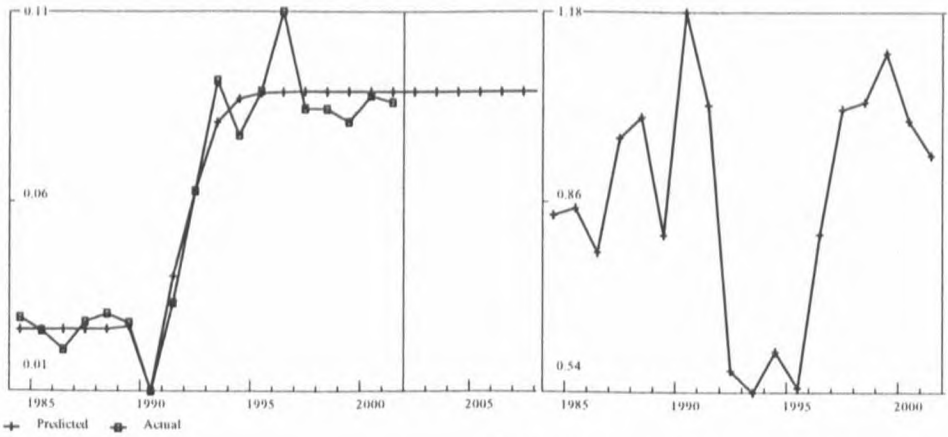
Fig. 1–11. Share of import in total output
From left to right: 1) constant prices of 2000; 2) price ratio, 2000 = 1; 3) current prices (below).

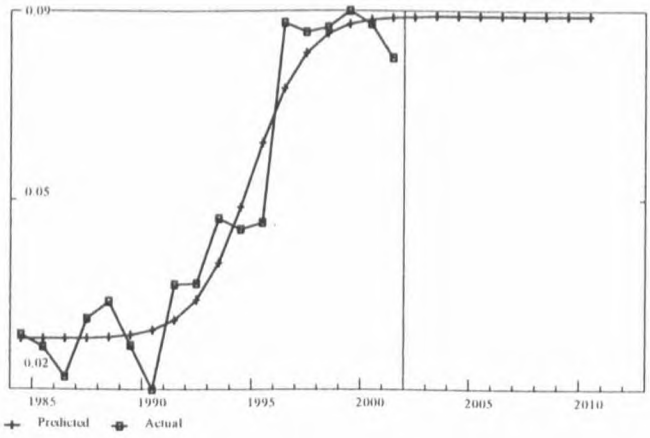
1. All commodities



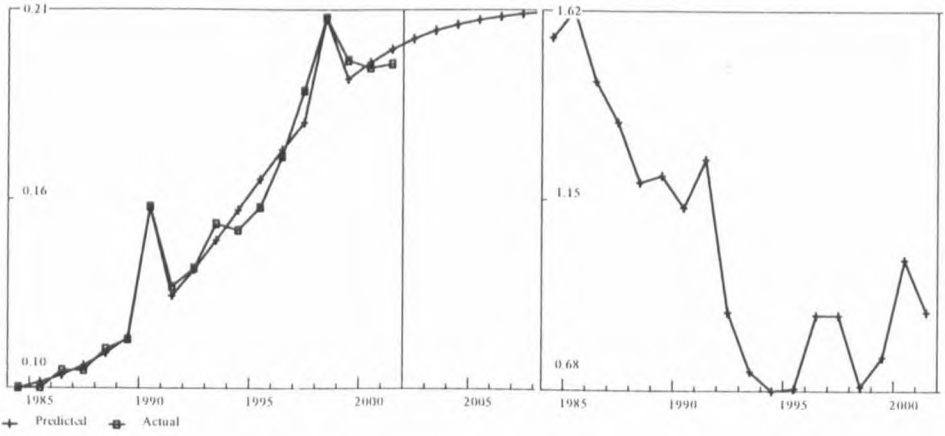


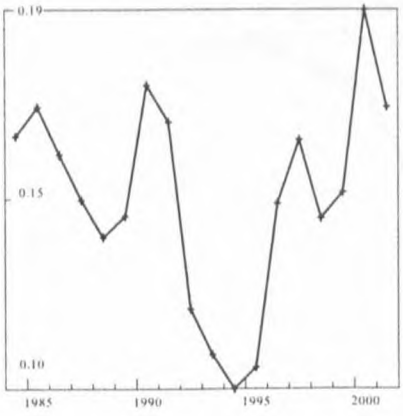
2. Products of agriculture, hunting, forestry and fishing



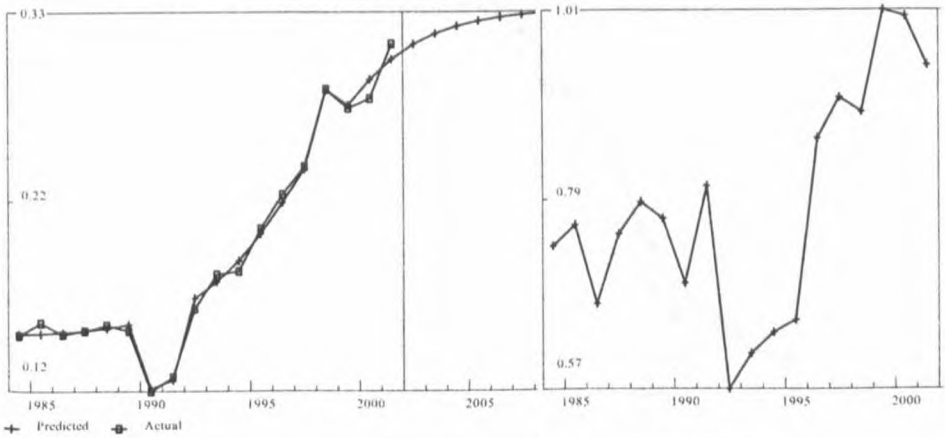


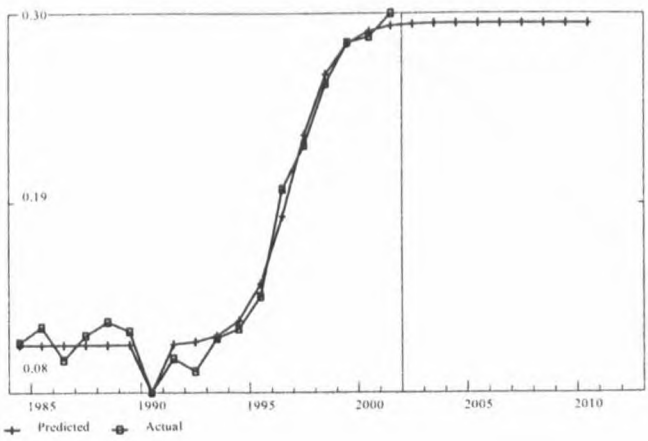
3. Products of mining, quarrying, fuels and energy



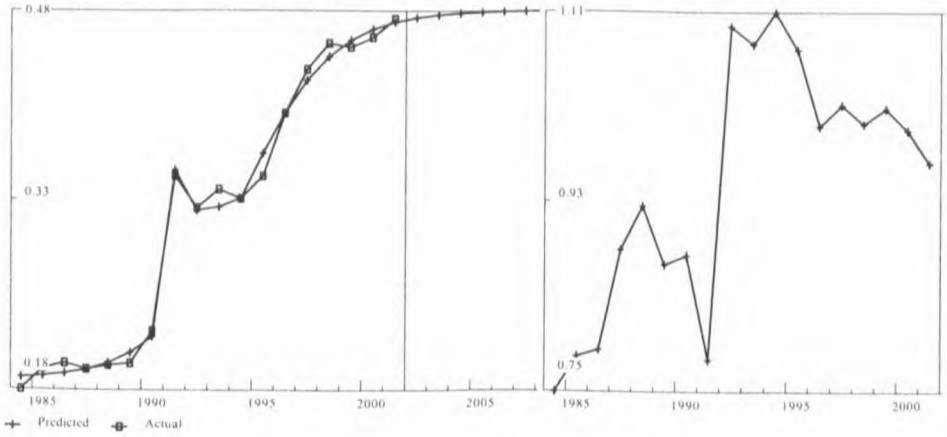


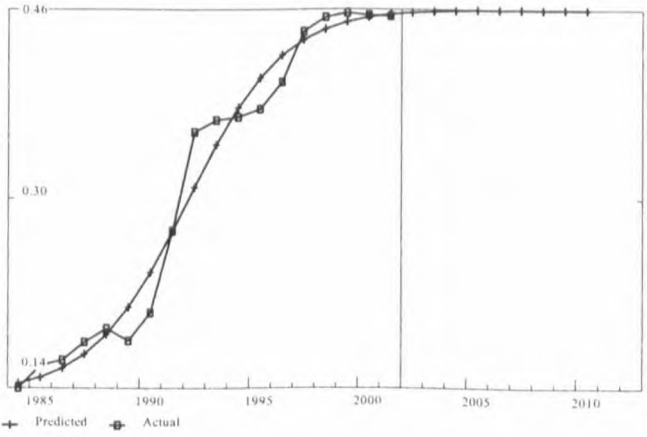
4. Basic metals and fabricated metal products



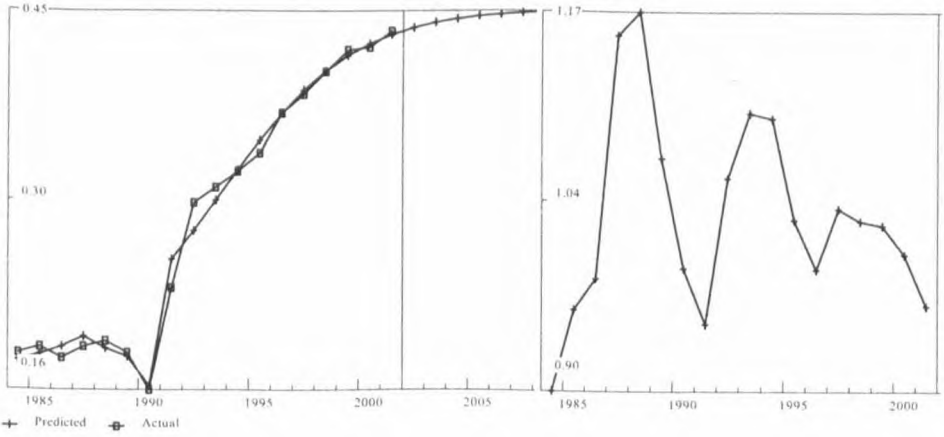


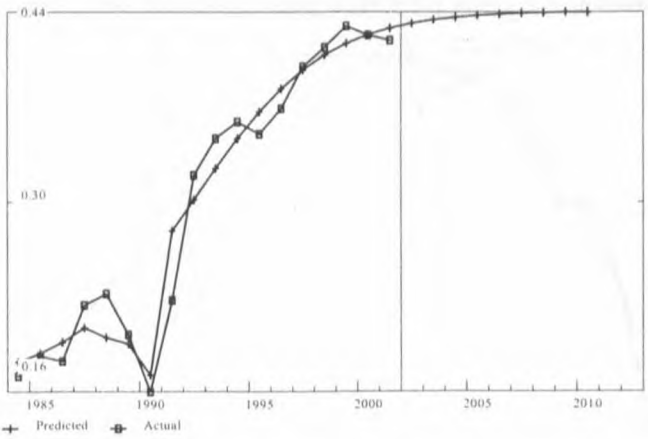
5. Machinery and equipment incl. electrical, optical and transport equipment



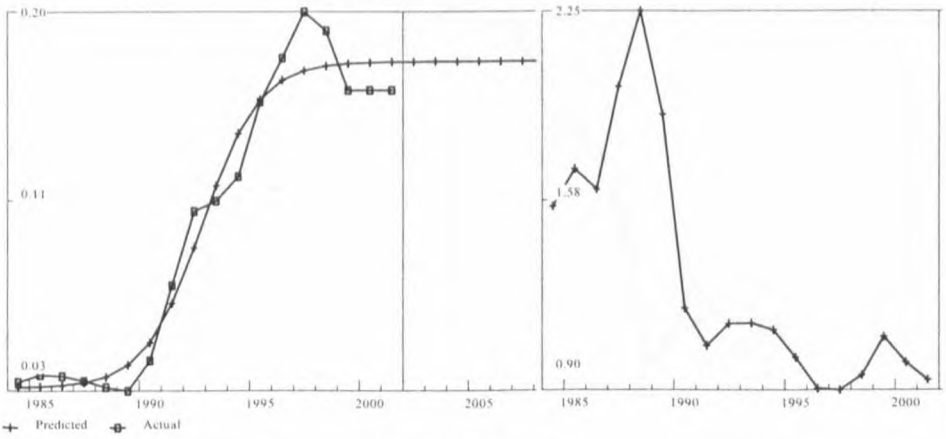


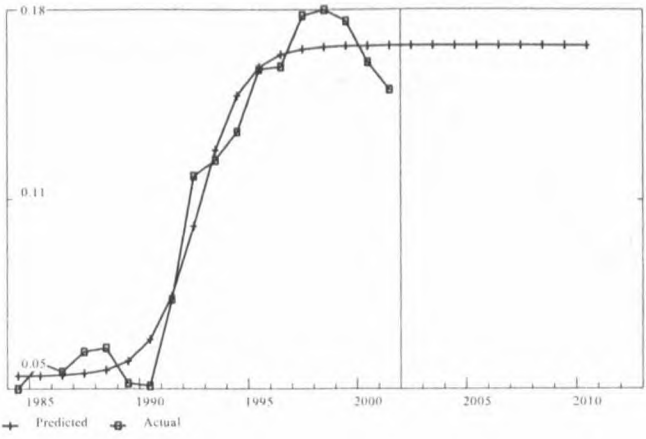
6. Chemical, rubber and plastic products



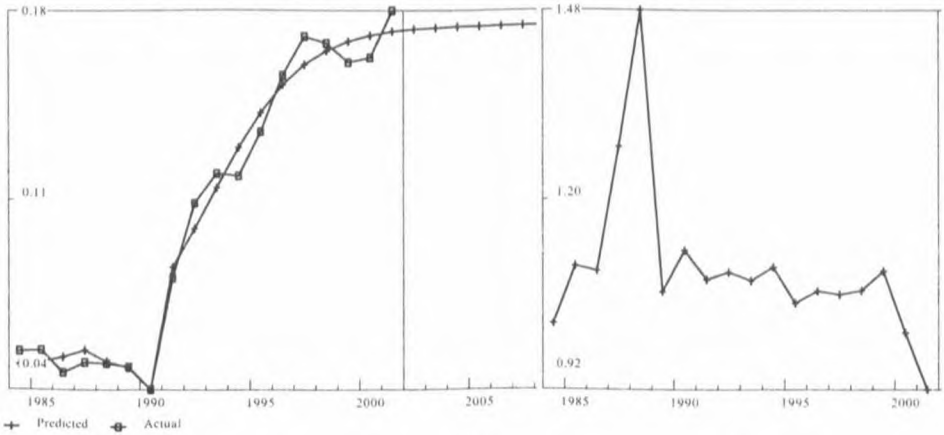


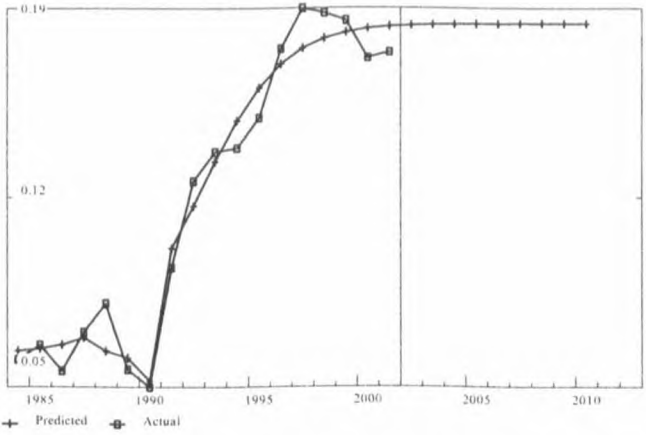
7. Other non-metallic mineral products



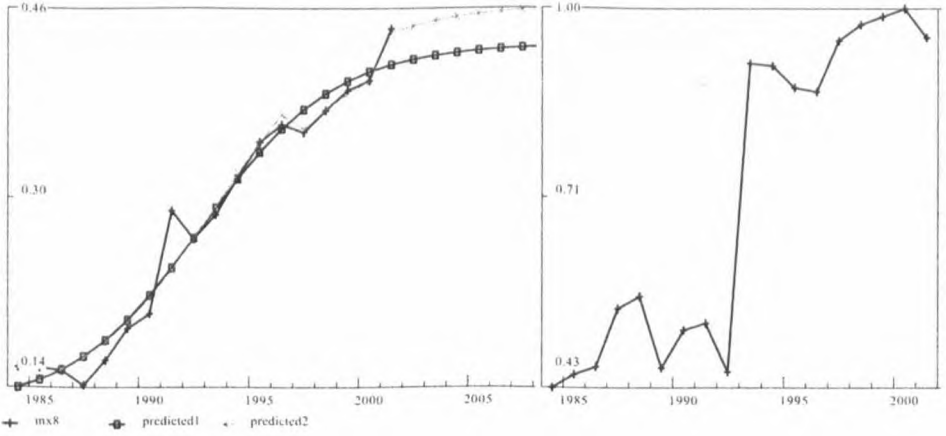


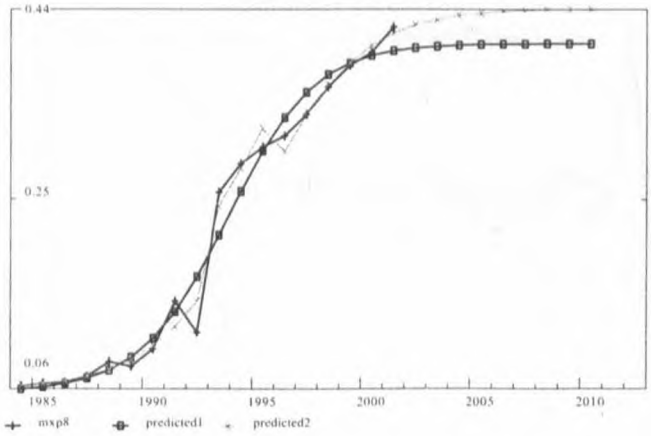
8. Wood, wood products, pulp, paper, paper products, recorded media, printing services



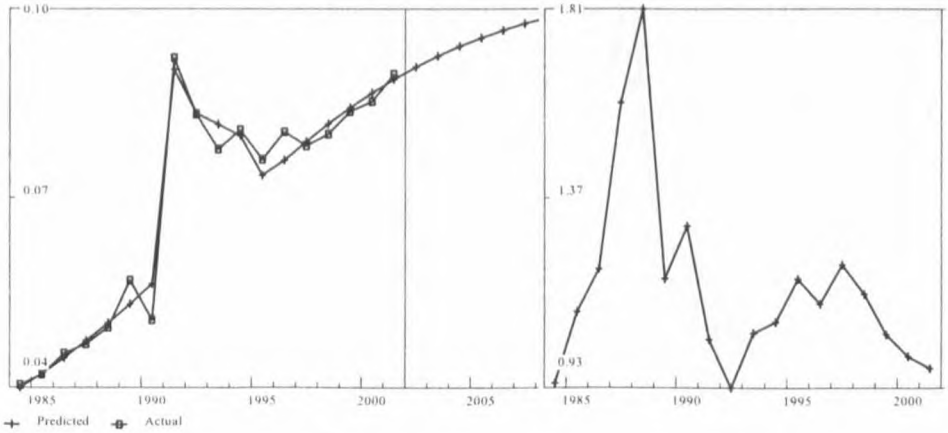


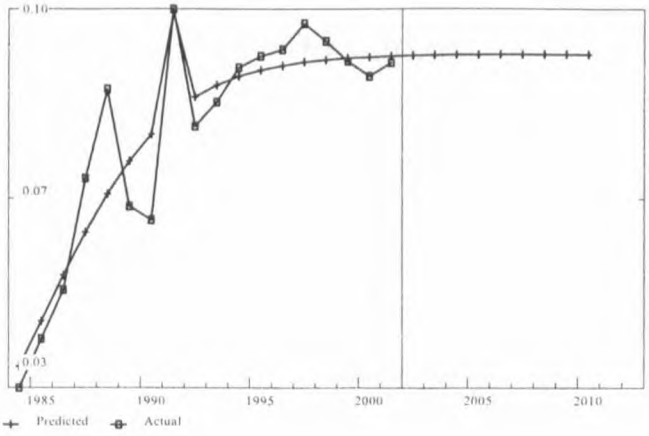
9. Textiles, textile products and wearing apparel,leather and leather products



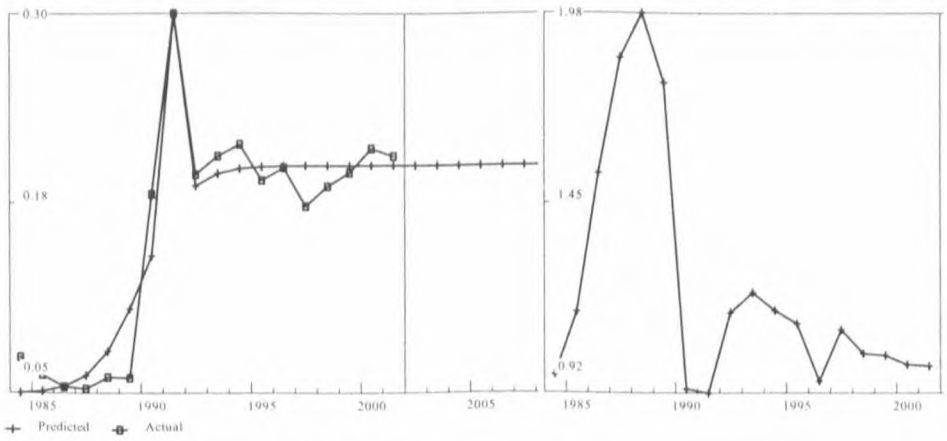


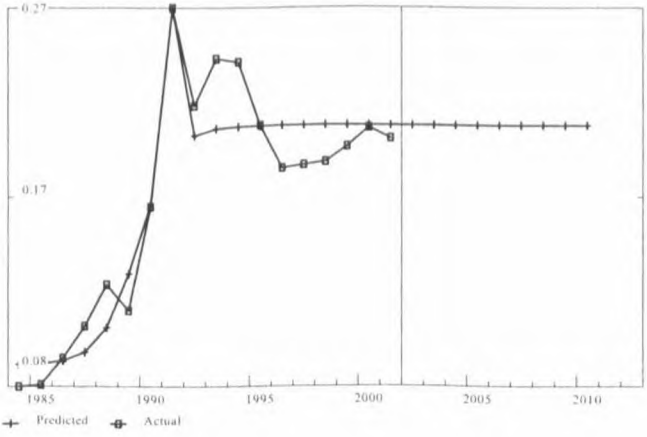
10. Food products, beverages and tobacco





11. Other commodities





III. THE EQUATIONS

Time trend equations might be used for simple projections but are not enough for making simulations.

The proposed equations have a logit form, which is often used in INFORUM models (Barnabani 1993, Wu and Pan 1998). It is quite similar to (1), it just assumes that the lower and upper asymptotes are 0 and 1. This assumption is necessary, as the explained variable is a share. The logit form can be estimated with OLS after transformation to:

$$\ln(mx/(1-mx)) = \alpha_0 + \alpha_1 EV_1 + \alpha_2 EV_2 + \ldots \qquad (2)$$

where:

$mx = m/(x+m)$ is the share of import in total output,

m – import in constant prices

x – output in constant prices

EV – explanatory variables.

The first explanatory variable is the price relation between import and domestic goods. The import prices were corrected with duties and other taxes related to imports, so the variables are not exactly the same as can be seen in Figures 1–11 on the right. These variables are present in all equations, because the price ratio, changes in duties and exchange rate are the most often used instruments for simulations. As there was no information about duties in the eighties, estimations were based on the period 1990–2001.

Changes in prices, duties and exchange rates are not enough to explain so dramatical rise in the shares. That is why all equations are supported with another variable. In the previous version, the role of the second explanatory variable was played by a measure of foreign direct investment. It was assumed that there were two effects of the FDI here: one was immediate and positive – foreign companies import machines and supplies. In longer term, with some time lags, the FDI make the domestic production more competitive, pushing out imports. Using the new data set it was not possible to separate these two effects, or they appeared insignificant, nevertheless, the new estimates showed that the FDI was rather not a good choice.

So, there are three types of „another variable" proposed:

Total output: $(x+m)$

Changes in total output in the form of chain index: $(x_t + m_t)/(x_{t-1} + m_{t-1})$

Time trend: $\ln(t)$ or $t^{\beta}, 0 < \beta < 1$

There are two reasons for introduction of total output or changes in total output as an explanatory variable:

1) in short term import is more flexible for changes in demand than domestic production. Domestic producers are often not able to quickly reflect an increase in demand. In the nineties (especially the first half) there was a problem of the structure of potential production, which didn't match well to the demand. In other words, producers were able to produce enough goods, but not exactly of the kind which would have been bought by people. This problem has more long-term character in the case of mining products and fuels. In this equation (and only in this equation) total output was used instead of its chain index.

2) in long term it may reflect the effect of scale and intra industry trade, but this is rather weak hypothesis.

IV. RESULTS OF ESTIMATION OF IMPORT SHARE EQUATIONS

Estimations were made using G7 software (see www.InforumWeb.umd.edu). The results are shown below in the form of the original printouts. All symbols used at the printouts are explained below (see the G7 Manual):

SEE	Standard error of estimate.
RSQ	Coefficient of multiple determination.
RHO	Autocorrelation coefficient of the residuals.
Obser	Number of observations.
SEE+1	The SEE for forecasts one period ahead using rho adjustment.
RBSQ	RSQ adjusted for degrees of freedom.
DW	Durbin-Watson statistic.
DoFree	(Degrees of freedom) = Obser – number of independent variables.
MAPE	Mean absolute percentage error.
Reg-Coef	Regression coefficient.
Mexval	(Marginal explanatory value) The percentage increase in SEE if this variable is left out of the regression.
t-value	Student t values.
Elas	Elasticity of the dependent variable with respect to this variable, evaluated at the means of both.
NorRes	Normalized residuals. The ratio of the sum of squares residuals after the introduction of this variable to the sum of squared residuals after all variables have been introduced.
Beta	What the regression coefficient would be if both the independent and dependent variables were scaled so that they had unit standard deviations.
F-stat	The Fisher F statistic.

Variable names are as follows:

m – import

x – output

$mx = m/(x+m)$

$tmx = \ln(mx/(1-mx))$

$pdmx$ – price ratio: import price deflator (including duties and other import taxes) divided by the price deflator of domestic production

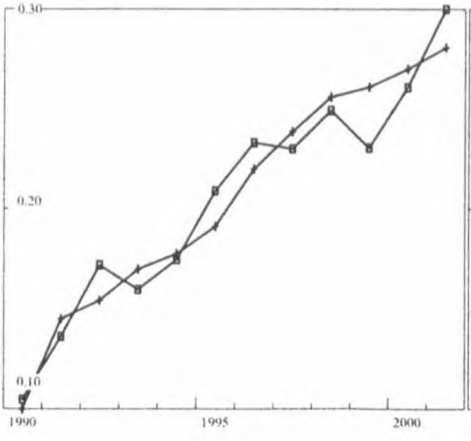
Numbers in square brackets, following the name of a variable indicate the time lag. Note, that the figures show import shares (mx) not the transformed variables tmx. Squares lines represent theoretical values, while + signs show actual shares.

```
:                                  All commodities
SEE    = 0.09  RSQ    = 0.9443 RHO =  -0.03 Obser  =   12 from 1990.000
SEE+1  = 0.09  RBSQ   = 0.9320 DW  =   2.05 DoFree =    9 to   2001.000
MAPE   = 6.05
Variable name       Reg-Coef Mexval  Elas  NorRes   Beta t-value F-Stat
0 tmx               - - - - - - - - - - - - - - - - - - - - - - - - - -
1 intercept          1.24315   20.1 -0.89  17.96          1.994
2 pmdx              -3.18635  240.1  2.51   1.62 -0.860 -9.753  76.33
3 (x+m)/(x[1]+m[1]) 0.84144   27.2 -0.62   1.00  0.208  2.357   5.55
```

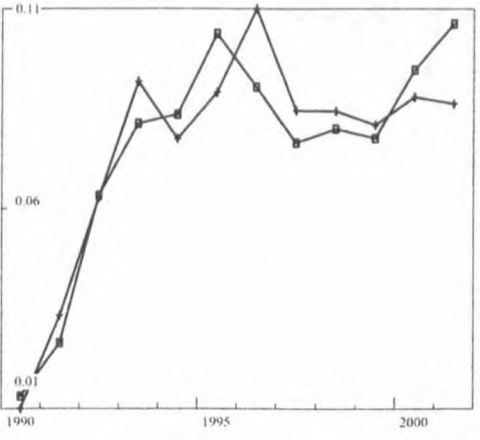
```
:          1. Products of agriculture, hunting, forestry and fishing

SEE    = 0.14  RSQ    = 0.9386 RHO =   0.05 Obser  =   12 from 1990.000
SEE+1  = 0.14  RBSQ   = 0.9249 DW  =   1.89 DoFree =    9 to   2001.000
MAPE   = 4.76
Variable name       Reg-Coef Mexval  Elas  NorRes  Beta  t-value F-Stat
0 tmx1              - - - - - - - - - - - - - - - - - - - - - - - - - -
1 intercept         -2.56773  253.5  0.97  16.28         -10.173
2 pmdx1             -1.10003  106.0  0.39   8.87 -0.466  -5.404  68.75
3 @log(t)            0.57502  197.9 -0.36   1.00  0.726   8.417  70.85
```

All commodities



Products of agriculture...



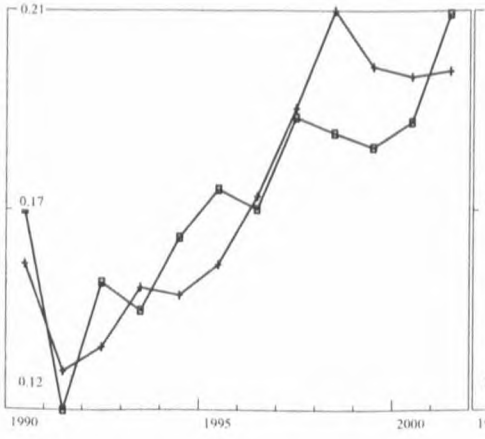

```
:          2.  Products of mining, quarrying, fuels and energy

SEE    = 0.09  RSQ    = 0.7455 RHO =   0.16 Obser  =   12 from 1990.000
SEE+1  = 0.09  RBSQ   = 0.6890 DW  =   1.68 DoFree =    9 to   2001.000
MAPE   = 4.96
Variable name       Reg-Coef Mexval  Elas  NorRes  Beta  t-value F-Stat
0 tmx2              - - - - - - - - - - - - - - - - - - - - - - - - - -
1 intercept         -4.04615  149.2  2.51   3.93         -6.847
2 pmdx2             -0.54767   54.1  0.29   3.44 -0.625  -3.516  13.18
3 (x2+m2)            0.00002   85.4 -1.80   1.00  0.833   4.685  21.95
```

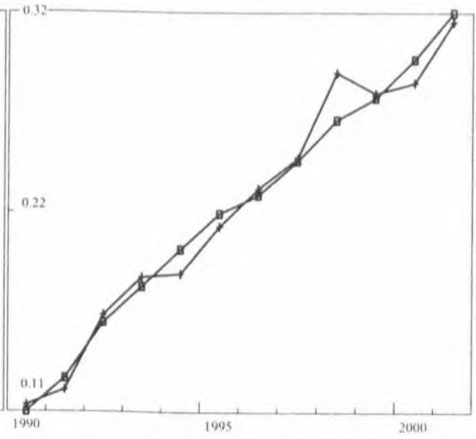
```
:          3.   Basic metals and fabricated metal products

SEE    =  0.05  RSQ   = 0.9817 RHO =    0.04 Obser  =    12 from 1990.000
SEE+1  =  0.05  RBSQ  = 0.9776 DW  =    1.92 DoFree =     9 to   2001.000
MAPE   =  3.59
Variable name          Reg-Coef Mexval  Elas  NorRes Beta  t-value F-Stat
0 tmx3                 - - - - - - - - - - - - - - - - - - - - - - - - - -
1 intercept           -2.23273  729.0  1.70   54.59          -24.688
2 pmdx3               -0.25954   13.4  0.15   29.74 -0.106   -1.606 241.14
3 @pow(t,.63)          0.35798  445.3 -0.85    1.00  1.066   16.082 258.64
```

Products of mining...



Basic metals...



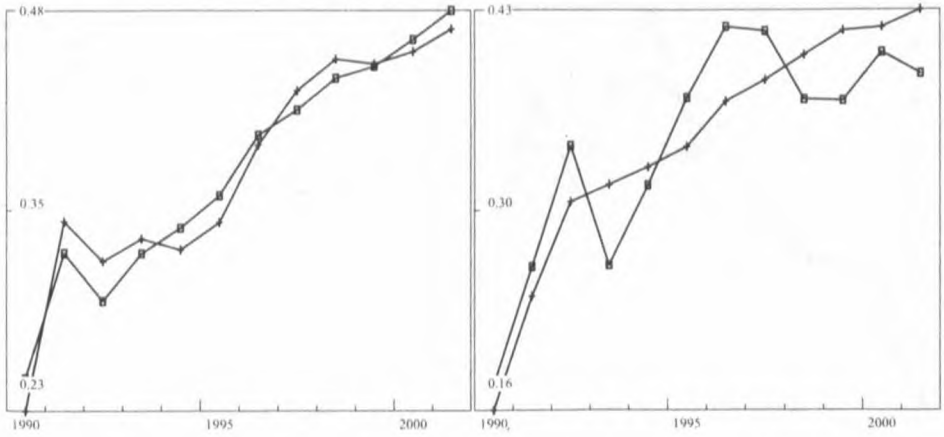

```
:          4.   Machinery and equipment incl. electrical, optical...

SEE    =  0.07  RSQ   = 0.9528 RHO =    0.36 Obser  =    12 from 1990.000
SEE+1  =  0.07  RBSQ  = 0.9423 DW  =    1.29 DoFree =     9 to   2001.000
MAPE   = 14.32
Variable name          Reg-Coef Mexval  Elas  NorRes  Bet  t-value F-Stat
0 tmx4                 - - - - - - - - - - - - - - - - - - - - - - - - - -
1 intercept           -0.56307   56.8  1.12   21.20          -3.623
2 pmdx4               -0.62525   70.5  1.31   21.16 -0.311   -4.141  90.88
3 @log(t)              0.43238  360.0 -1.43    1.00  1.012  13.470 181.45


:                  5.   Chemical, rubber and plastic products

SEE    =  0.16 RSQ   = 0.8274 RHO =    0.35 Obser  =    12 from 1990.000
SEE+1  =  0.16 RBSQ  = 0.7890 DW  =    1.29 DoFree =     9 to   2001.000
MAPE   = 30.06
Variable name            Reg-Coef Mexval Elas NorRes Beta t-value F-Stat
0 tmx5                   - - - - - - - - - - - - - - - - - - - - - - - - -
1 intercept              -1.57788  42.9  2.34   5.79         -3.062
2 pmdx5                  -1.42900  92.3  2.52   4.31 -0.706 -4.927 21.57
3 (x5+m5)/(x5[1]+m5[1]) 2.39433 107.5 -3.86   1.00  0.781  5.455 29.75
```

Machinery and equipment... Chemical, rubber...



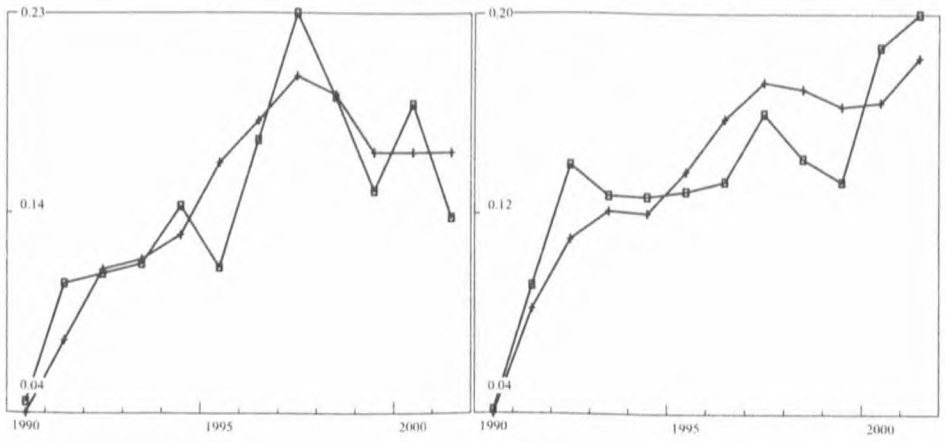

```
:                    6.   Other non-metallic mineral products

SEE   = 0.20  RSQ   = 0.8418 RHO =  -0.05 Obser  =   12 from 1990.000
SEE+1 = 0.20  RBSQ  = 0.8067 DW  =   2.10 DoFree =    9 to   2001.000
MAPE  = 8.63
Variable name          Reg-Coef Mexval Elas NorRes Beta t-value F-Stat
0 tmx6                 - - - - - - - - - - - - - - - - - - - - - - - -
1 intercept            -2.95655   40.2  1.56 6.32         -2.947
2 pmdx6                -1.96550   72.2  1.17 3.18 -0.572 -4.207  23.95
3 (x6+m6)/(x6[1]+m6[1]) 3.07866   78.5 -1.73 1.00  0.603  4.434  19.66

:             7.  Wood, wood products, pulp, paper, paper products,...

SEE   = 0.15  RSQ   = 0.8815 RHO =   0.49 Obser  =   12 from 1990.000
SEE+1 = 0.13  RBSQ  = 0.8552 DW  =   1.02 DoFree =    9 to   2001.000
MAPE  = 7.57
Variable name          Reg-Coef Mexval  Elas NorRes Beta t-value F-Stat
0 tmx7                 - - - - - - - - - - - - - - - - - - - - - - - -
1 intercept            -0.34748   1.2   0.18 8.44         -0.466
2 pmdx7                -3.46830 127.4   2.05 4.56 -0.704 -6.127  33.47
3 (x7+m7)/(x7[1]+m7[1]) 2.13597 113.5  -1.23 1.00  0.650  5.659  32.02
```

Other non-metallic... Wood, wood products...

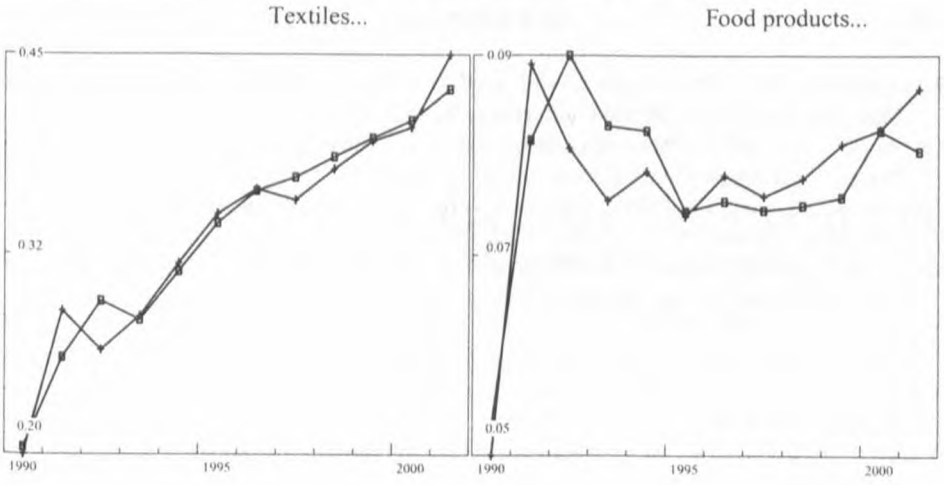



```
:            8.   Textiles, textile products and wearing apparel,...

SEE    = 0.07  RSQ    = 0.9488 RHO =  -0.38 Obser  =    12 from 1990.000
SEE+1  = 0.06  RBSQ   = 0.9374 DW  =   2.75 DoFree =     9 to   2001.000
MAPE   = 8.65
Variable name          Reg-Coef Mexval Elas  NorRes  Beta t-value F-Stat
0 tmx8                 - - - - - - - - - - - - - - - - - - - - - - - - - -
1 intercept            -1.13653  205.5  1.63  19.54          -8.661
2 pmdx8                -0.42205   21.9  0.54  11.77 -0.243 -2.091   83.42
3 @log(t)               0.48940  243.1 -1.17   1.00  1.147  9.847   96.97


:            9.    Food products, beverages and tobacco

SEE    = 0.08  RSQ    = 0.8025 RHO =   0.18 Obser  =    12 from 1990.000
SEE+1  = 0.08  RBSQ   = 0.7587 DW  =   1.63 DoFree =     9 to   2001.000
MAPE   = 2.70
Variable name          Reg-Coef Mexval  Elas NorRes Beta t-value F-Stat
0 tmx9                 - - - - - - - - - - - - - - - - - - - - - - - - -
1 intercept            -2.61092  129.3  1.06  5.06          -6.191
2 pmdx9                -0.79159   54.3  0.36  2.54 -0.544 -3.526   18.29
3 (x9+m9)/(x9[1]+m9[1])0.99103   59.3 -0.42  1.00  0.574  3.720   13.84
```



In many cases relative prices and changes in total output appeared to explain quite a lot of the process described on Fig. 1–11 by the transition curves. In other cases, where total output was not significant (or has low Mexval), the time trend was put in the log form, or as a root. Thus, the reasons for transition process were decomposed into two: changes in prices and other reasons. The log trend, which is similar to a root where beta is close to zero, means that the non-price factors raised the share strongly in the beginning of the analyzed period (1990–2001), weakening very quickly. This could be observed for agricultural products, machinery and textiles, and means, that these branches have completed the transition period. Higher value of beta, like 0.63 estimated[1] for metals, suggests, that the transition process in this industry is going to continue (see also Fig. 4).

For the category "other commodities" no reasonable equation could be proposed.

The main goal of the calculations showed above was to make the import equations operational. The first, symptomatic version of the equations will serve as the base for long term projections, the second will be used to simulate the reaction of imports on changes in duties, as well as in domestic prices. To do this, these equations will be included into IMPEC with a bridge matrix converting results obtained from 10 equations into 57 branches. Construction of this bridge will probably bring other interesting findings.

[1] Equations with time trend were first estimated using G7 with *nl* (nonlinear estimation) command. If beta appeared to be under 0.01, the root was replaced with log. Then the equations were estimated using *r* command (OLS) with beta given explicitly.

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Michał Przybyliński

RÓWNANIA UDZIAŁU IMPORTU W POPYCIE GLOBALNYM DLA MODELU IMPEC

Blok importu w typowym modelu INFORUM zawiera równania opisujące udział importu w popycie całkowitym. Podobne rozwiązanie przyjęto dla polskiego modelu IMPEC. W opracowaniu przedstawiono wyniki oszacowań takich właśnie równań zbudowanych w dwóch wariantach. Pierwszy z nich polegał na zastosowaniu trendu logistycznego i oszacowaniu krzywych, ukazujących transformację (wzrost otwartości) polskiej gospodarki w latach 1985-2001. Wariant ten, pokazujący tempo przemian charakterystyczne dla poszczególnych analizowanych grup towarów, może być w prosty sposób wykorzystany do projekcji udziałów importu w popycie całkowitym, co pokazano.

Drugi wariant, to równania przyczynowo-skutkowe, uzależniające badane udziały od relacji cen importu do cen krajowych. Drugą zmienną objaśniającą w równaniach jest poziom lub przyrost popytu, a w niektórych przypadkach zmienna czasowa o specjalnie dobranej postaci. Takie równania pozwalają na symulację zmian relacji cenowych (łącznie ze zmianami kursu walutowego) i stanowią alternatywę dla równań trendu w przypadku bardziej złożonych analiz symulacyjnych.