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# Inflationary effect of crude oil prices in Turkey

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## Abstract

It is generally acknowledged that changes in oil prices affect economic welfare in ways that are not entirely reflected in transactions in the oil market. In this article, by using the 1990 input–output table, the inflationary effects of crude oil prices are investigated for Turkey. Under fixed nominal wages, profits, interest and rent earnings, the effect of increasing prices of oil on inflation is limited. However, when wages and the other three factors of income (profit, interest and rent) are adjusted to the general price level that includes the oil price increases, the inflationary effect of oil prices becomes significant. Hence, indexation could have very severe effects on an economy when oil prices increase and, in some cases, could even lead to hyperinflation.

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## 1. Introduction

It is generally acknowledged that changes in oil prices affect economic welfare in ways that are not entirely reflected in transactions in the oil market [1]. From the second world war to the 1970s, the price of crude oil showed very little nominal change. However, beginning from the early 1970s, oil price increases left deep marks on the world economy. The 1973–1974 and 1979–1980 crises were followed by the 1985–1986 inverse shock and nowadays oil prices are again making big fluctuations. During the 1998–2000 period, a 300% rise occurred and oil prices reached to 36 dollars per barrel (September, 2000).

Various studies have been performed to determine if there is a relationship between input prices and the general price level. Aydoğuş [2], Goto [3], Hoffman and Jarass [4]

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and Olgun [5] used input–output tables for this relationship. Cebula and Fewer [6] and Salvatore [7] used macroeconomic modeling to explain the effects of the oil shocks occurred in the 1970s. Lastly, Boyd and Uri [8] followed computational general equilibrium modeling to analyze the same effects.

In this regard, Kibritçioğlu and Kibritçioğlu [9] (hereafter K&K) look at the effect of the crude oil price increases on inflation in Turkey. When they use the input–output analysis to investigate the effect of oil prices on the general price level, the main assumption of their specification was that nominal wages, profits, interest and rents were fixed. After giving 20% price shocks to crude oil in the input–output tables of 1979, 1985 and 1990, the general price level rises by 4.45%, 1.66% and 1.08%, respectively, *ceteris paribus*.<sup>1</sup> They also look at the relationship between oil prices and the general price level within the VAR framework after controlling macroeconomic policy variables like money supply and exchange rate. Neither Granger causality tests, nor impulse response functions, nor the variance decomposition analysis indicate a statistically significant relationship between oil prices and the general price level. According to these results, K&K conclude that the commonly believed relationship between oil prices and inflation does not hold for Turkey. An increase in oil prices has a very small effect on the general price level. Even if Berument and Malatyali [11] and Berument [12] discuss the effect of increase in input prices on general price level, to the best of our knowledge, the K&K study is the only one that looked at the effect of oil prices on the general price level.

While Bruno and Sachs [13, pp. 154–176] were explaining the main reasons for the 1972–1973 shock, they stated that the contribution of labor costs to the general price level is one of the most important reasons for deepening the recession. They argue that the 1979–1980 oil shock effect is not as great as the one in 1972–1973 because labor cost could not be adjusted to the new general price level in the 1979–1980 period. Not only the behavior of wages, but also the behavior of the other factor inputs like profit, interest and rent affect the general price level. In the K&K study, wage, profit, interest and rent earnings are fixed in nominal values. For the 1990 input–output table only 3.56% of the cost is due to oil prices. Total inputs (mostly raw materials) make up 46.8% of the total cost of the Turkish manufacturing sector. The contribution of wages to the total cost of the sectors is 17.22% on the whole and other factors of income (mainly interest, profits and rents) make up 35.96% of the total cost. It is clear that the share of oil in Turkish industrial production is not high. The purpose of this paper is to incorporate the effect of wage, profit, interest and rent behavior to the oil-general price relationship and observe how the relationship changes by using the most recent input–output table (1990 input–output table). We did not utilize any econometric method to analyze the effect of oil prices. The reason for this is that figures for the income factors are available only after 1996 on a quarterly basis from national income accounts, which do not provide a long series for observing how the general price level increases under different income factor price adjustments.

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<sup>1</sup> K&K use the iteration method rather than the Leontief's inversion method to analyze the effect of oil price increases on the general price level (for the application of the methodology see Ref. [10]).

The next section introduces the method, the third section analyzes the behavior of the general price level under different levels of adjustments for wage, profit, interest and rent earnings. The last section summarizes the results and concludes the paper.

## 2. Methodology

In this section of the study, we used the input–output table prepared by the State Statistical Institute of Turkey for the year 1990. The 1990 input–output table was the most recent table available when this study was performed. In this study, we used the iteration method, rather than the Leontief’s [14] inversion method, to calculate how much the general price level changes when oil prices increase (for the description of these models, see Ref. [10]). The main reason for using the iteration method is that when we allow the adjustment of the wage, profit, interest and rent earnings to the general price level, we modify the input–output table such that the input–output table is no longer positive definite; hence, the identity matrix minus the input–output table may not be invertible, or negative semi-definite.

In order to see how the iteration method is performed the method is explained by using the condensed input–output table of 1990, as calculated by K&K (Table 1). However, when the iteration method is performed, the original input–output table with 64 sectors is used in this article. Intermediate sectoral input components, wages and other income factors are seen with their nominal values. In the last column of the table, the total intermediate consumption of each sector of the Turkish economy is calculated and the last row represents the total output of the sectors individually. For the convenience of the analysis, we equate all sectors’ total output price level to 100 one by one and find the shares of all inputs of the sectors in the total output (Table 2). As an example, 67.62% of oil refinement sector input comes from the industry of crude oil and natural gas production.

At the first iteration, we consider a 20% increase in crude oil prices.<sup>2</sup> Crude oil prices are increased by 20% in the third step (Table 3). This shock is given by multiplying all entries of the row of crude oil and natural gas production by 1.20. (This shows that oil prices increase by 20% and now each sector’s crude oil expenses increase by 20%.) A 0.36% increase is observed in the general price level. But the largest increase occurs in the cost of oil refinement sector with 13.52%. Each sector should adjust itself to this cost increase by increasing input prices. In the second iteration, these cost increases affect the same sector’s input prices (Table 4). For example, since oil refinement sector cost increased by 13.52%, so as not to be worse off, entries of oil refinement sector row are multiplied by 1.1352. They regulated their prices to the new equilibrium level. Similar iterative method is used for all other sectors. Finally, the general price level increase reached 0.87%. In the third iteration, all sectors are affected by these oil price changes (Table 5). This can be seen in the last row of the input–output table after the

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<sup>2</sup> A 20% increase in oil prices parallels that of K&K. Due to the nature of the input–output tables, the ratio of general price level increases to oil price increases is constant. To calculate how much the general price level increases for a 100% increase in oil prices, we multiply 1.08 by 5.

Table 1  
Condensed input–output table of the Turkish economy (in nominal values, in billion TL, 1990)

Sales	Input user sectors									Total
	A1	A2	A3	A4	A5	A6	A7	A8	A9	
A1 Primary producing industries <sup>a</sup>	14926.4	59.0	0.0	22115.4	0.0	4.5	0.5	0.7	2954.0	40060.5
A2 Mining and stone quarrying	12.6	14.4	0.0	2385.9	0.0	505.0	17.9	1228.0	399.1	4562.9
A3 Crude oil and natural gas production	0.0	0.0	0.0	130.4	10242.4	803.6	18.8	0.0	17.9	11213.1
A4 Manufacturing industries	6196.5	393.5	71.6	74164.8	24.5	444.7	189.9	21352.5	17889.3	120727.3
A5 Oil refinement	2214.3	311.6	31.3	5541.7	47.1	146.4	75.4	1159.3	12624.0	22151.1
A6 Electricity	96.0	231.7	9.5	5654.3	118.1	284.8	326.6	86.0	1051.7	7858.7
A7 Gas manufacturing, water works	134.1	1.8	0.0	330.2	4.0	4.3	16.6	129.3	623.9	1244.2
A8 Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A9 Service industries	7436.0	439.5	165.5	31299.3	573.2	698.3	148.3	8773.0	33898.0	83431.1
Total inputs	31015.9	1451.5	277.9	141622.0	11009.3	2891.6	794.0	32728.8	69457.9	291248.9
Labor costs	7407.0	1968.5	70.7	19242.7	186.3	1965.9	468.1	13317.9	62475.0	107102.1
Other income factors	58404.2	1895.7	1287.6	39630.8	3951.8	2609.1	1123.3	9956.5	104812.0	223671.0
Total output cost	96827.1	5315.7	1636.2	200495.5	15147.4	7466.7	2385.4	56003.2	236744.9	622022.1

<sup>a</sup>Includes Agriculture, Animal Husbandry, Forestry and Fishing.



Table 3  
Inflationary effects of 20% crude oil price increase at the end of the first iteration (1990)

Sales	Input user sectors									Total
	A1	A2	A3	A4	A5	A6	A7	A8	A9	
A1 Primary producing industries	15.42	1.11	0.00	11.03	0.00	0.06	0.02	0.00	1.25	6.44
A2 Mining and stone quarrying	0.01	0.27	0.00	1.19	0.00	6.76	0.75	2.19	0.17	0.73
<b>A3 Crude oil and natural gas production</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.08</b>	<b>81.14</b>	<b>12.91</b>	<b>0.95</b>	<b>0.00</b>	<b>0.01</b>	<b>2.16</b>
A4 Manufacturing industries	6.40	7.40	4.38	36.99	0.16	5.96	7.96	38.13	7.56	19.41
A5 Oil refinement	2.29	5.86	1.91	2.76	0.31	1.96	3.16	2.07	5.33	3.56
A6 Electricity	0.10	4.36	0.58	2.82	0.78	3.81	13.69	0.15	0.44	1.26
A7 Gas manufacturing, water works	0.14	0.03	0.00	0.16	0.03	0.06	0.70	0.23	0.26	0.20
A8 Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A9 Service industries	7.68	8.27	10.11	15.61	3.78	9.35	6.22	15.67	14.32	13.41
Total inputs	32.03	27.31	16.98	70.65	86.20	40.88	33.44	58.44	29.34	47.18
Labor costs	7.65	37.03	4.32	9.60	1.23	26.33	19.62	23.78	26.39	17.22
Other income factors	60.32	35.66	78.69	19.77	26.09	34.94	47.09	17.78	44.27	35.96
Total output cost	100.00	100.00	100.00	100.01	113.52	102.15	100.16	100.00	100.00	<b>100.36</b>

Table 4  
Inflationary effects of 20% crude oil price increase at the end of the second iteration (1990)

Sales	Input user sectors									Total
	A1	A2	A3	A4	A5	A6	A7	A8	A9	
A1 Primary producing industries	15.42	1.11	0.00	11.03	0.00	0.06	0.02	0.00	1.25	6.44
A2 Mining and stone quarrying	0.01	0.27	0.00	1.19	0.00	6.76	0.75	2.19	0.17	0.73
A3 Crude oil and natural gas production	0.00	0.00	0.00	0.08	81.14	12.91	0.95	0.00	0.01	2.16
A4 Manufacturing industries	<b>6.40</b>	<b>7.40</b>	<b>4.38</b>	<b>37.00</b>	<b>0.16</b>	<b>5.96</b>	<b>7.96</b>	<b>38.13</b>	<b>7.56</b>	<b>19.41</b>
A5 Oil refinement	<b>2.60</b>	<b>6.65</b>	<b>2.17</b>	<b>3.14</b>	<b>0.35</b>	<b>2.23</b>	<b>3.59</b>	<b>2.35</b>	<b>6.05</b>	<b>4.04</b>
A6 Electricity	<b>0.10</b>	<b>4.45</b>	<b>0.59</b>	<b>2.88</b>	<b>0.80</b>	<b>3.90</b>	<b>13.99</b>	<b>0.16</b>	<b>0.45</b>	<b>1.29</b>
A7 Gas manufacturing, water works	<b>0.14</b>	<b>0.03</b>	<b>0.00</b>	<b>0.16</b>	<b>0.03</b>	<b>0.06</b>	<b>0.70</b>	<b>0.23</b>	<b>0.26</b>	<b>0.20</b>
A8 Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A9 Service industries	7.68	8.27	10.12	15.61	3.78	9.35	6.22	15.67	14.32	13.41
Total inputs	32.34	28.19	17.26	71.09	86.26	41.23	34.17	58.73	30.07	47.70
Labor costs	7.65	37.03	4.32	9.60	1.23	26.33	19.62	23.78	26.39	17.22
Other income factors	60.32	35.66	78.69	19.77	26.09	34.94	47.09	17.78	44.27	35.96
Total output cost	100.31	100.89	100.27	100.45	113.58	102.50	100.88	100.29	100.73	<b>100.87</b>

Table 5  
Inflationary effects of 20% oil price increase at the end of the third iteration (1990)

Sales	Input user sectors									Total
	A1	A2	A3	A4	A5	A6	A7	A8	A9	
A1 Primary producing industries	15.46	1.11	0.00	11.06	0.00	0.06	0.02	0.00	1.25	6.46
A2 Mining and stone quarrying	0.01	0.27	0.00	1.20	0.00	6.82	0.76	2.21	0.17	0.74
A3 Crude oil and natural gas production	0.00	0.00	0.00	0.08	81.36	12.95	0.95	0.00	0.01	2.17
A4 Manufacturing industries	6.43	7.44	4.40	37.16	0.16	5.98	8.00	38.30	7.59	19.50
A5 Oil refinement	2.60	6.66	2.17	3.14	0.35	2.23	3.59	2.35	6.06	4.04
A6 Electricity	0.10	4.47	0.60	2.89	0.80	3.91	14.03	0.16	0.46	1.30
A7 Gas manufacturing, water works	0.14	0.03	0.00	0.17	0.03	0.06	0.70	0.23	0.27	0.20
A8 Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A9 Service industries	7.74	8.33	10.19	15.73	3.81	9.42	6.26	15.78	14.42	13.51
Total inputs	32.48	28.31	17.35	71.42	86.52	41.43	34.31	59.04	30.22	47.92
Labor costs	7.65	37.03	4.32	9.60	1.23	26.33	19.62	23.78	26.39	17.22
Other income factors	60.32	35.66	78.69	19.77	26.09	34.94	47.09	17.78	44.27	35.96
Total output	100.45	101.01	100.37	100.79	113.83	102.70	101.03	100.59	100.88	101.10



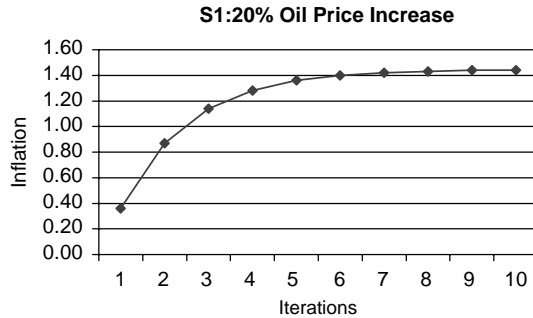


Fig. 1.

third time iteration, the general price level rise is 1.1%. This iterative method is kept up to 10 iterations. According to Hoffmann and Jarass [4] the effects of these shocks can be negligible after fifth or sixth iteration.

### 3. Input–output analysis

In this section we consider various possible behavior of wage, profit, interest and rent and their effect on the general price level. Here, we consider eight different scenarios. In the first one, parallel with K&K, the crude oil prices increase by 20%, nominal wages and the other three income factors were fixed (S1). In other words, real payment made for wages, profit, interest and rent decreased. Thus, the final inflationary effect of this scenario is only 1.44% after 10 iterations (Fig. 1).<sup>3</sup> We also report the number of these eight simulations in Table 6. However, in the second scenario (S2) after the crude oil price shock, wages are adjusted to the general price level such that real wages do not change. After 10 iterations, the general price level increase is 2.01% (Fig. 2). It is important to note that with full indexation, the price effect is higher than the one without indexation and price increases converge to a certain level after 10 iterations in both scenarios (S1 and S2). Hence, even if inflation is observed for a period of time, the price level stabilizes.

As stated before, nearly 35.96% of the total sectoral cost is other income factors mainly profits, interests and rents. The behavior of these factors during the oil price shock is also very important. In the next three scenarios, wages are fixed and other income factors are adjusted to the new general price levels—while a 20% increase occurs in crude oil price—by a fraction of general price increases: 1/3, 2/3, 3/3 (S3, S4 and S5). We choose these three different rates for the adjustment of the other three

<sup>3</sup> Here, there is a difference between K&K's result and ours when there is an increase of 20% in oil prices. The reason is that K&K use two types of inputs for all the sectors considered in the input–output table: domestic and foreign. K&K's model forces non-substitutability of the inputs. However, we relax this assumption by combining those domestic and foreign inputs. The basic reason for this is that Turkey has been implementing liberalized trade regime since 1987 and joined the European Custom Union in 1996.

Table 6  
Total inflationary effect of various scenarios (1990, % increase)

Scenarios	Iterations									
	1	2	3	4	5	6	7	8	9	10
<b>S1</b>	0.36	0.87	1.14	1.28	1.36	1.4	1.42	1.43	1.44	1.44
<b>S2</b>	0.36	0.94	1.32	1.58	1.75	1.85	1.92	1.96	1.99	2.01
<b>S3</b>	0.36	0.92	1.27	1.5	1.65	1.74	1.8	1.84	1.86	1.87
<b>S4</b>	0.36	0.96	1.41	1.76	2.02	2.21	2.35	2.46	2.54	2.6
<b>S5</b>	0.36	1	1.56	2.06	2.49	2.86	3.17	3.45	3.69	3.89
<b>S6</b>	0.36	0.98	1.47	1.85	2.15	2.37	2.54	2.67	2.77	2.85
<b>S7</b>	0.36	1.02	1.62	2.17	2.65	3.08	3.46	3.79	4.09	4.35
<b>S8</b>	0.36	1.07	1.79	2.53	3.28	4.04	4.8	5.57	6.35	7.13

**S1:** Inflationary effect of 20% oil price increase (1990, wages and other factor income fixed),  
**S2:** Inflationary effect of 20% oil price increase (1990, wages adjusted, other income factors fixed),  
**S3:** Inflationary effect of 20% oil price increase (1990, wages fixed, 1/3 of other income factors adjusted),  
**S4:** Inflationary effect of 20% oil price increase (1990, wages fixed, 2/3 of other income factors adjusted),  
**S5:** Inflationary effect of 20% oil price increase (1990, wages fixed, 3/3 of other income factors adjusted),  
**S6:** Inflationary effect of 20% oil price increase (1990, wages and 1/3 of other income factors adjusted),  
**S7:** Inflationary effect of 20% oil price increase (1990, wages and 2/3 of other income factors adjusted),  
**S8:** Inflationary effect of 20% oil price increase (1990, wages and 3/3 of other income factors adjusted).

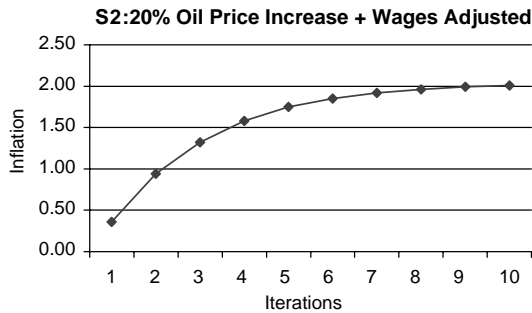


Fig. 2.

income factors because the exact share of the profit, interest and rent in the 35.96% share of the total sectoral cost is not known.

When these three income factors adjust to the general price level by 1/3, 2/3 and 3/3 of the general price level changes, the general price level increases by 1.87%, 2.6% and 3.89%, respectively after 10 iterations. Figs. 3–5 show that the effect of oil price increases under scenarios S3, S4 and S5 for 10 iterations. The same method is used in scenario 2 while making the analysis. It is important to note that the price level increases converge to a certain level under scenarios S3 and S4 but not under S5. S5 suggests that a one-time increase in crude oil will bring persistent price increase (inflation) if the profits, interest and rents adjust themselves fully to the general price level.

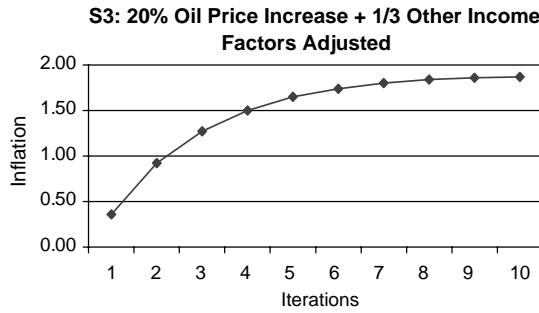


Fig. 3.

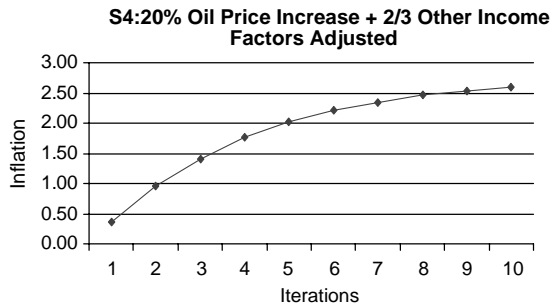


Fig. 4.

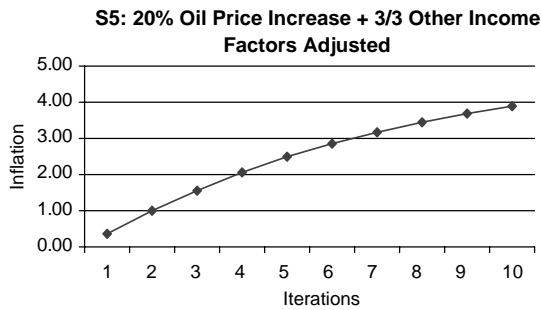


Fig. 5.

Finally, both wages and other income factors are adjusted to the general price level. Wages are again adjusted fully to the general price level and other income factors are adjusted in three levels: 1/3, 2/3, 3/3 of the general price level increases (scenarios S6–S8). The inflationary effects are now much higher: 2.85%, 4.35%, 7.13% (after 10 iterations) (Figs. 6–8). Another interesting thing about the last scenario, where wages and 3/3 of other income factors are adjusted to the new price level is that general

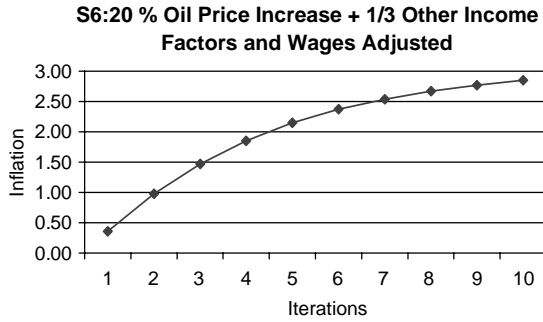


Fig. 6.

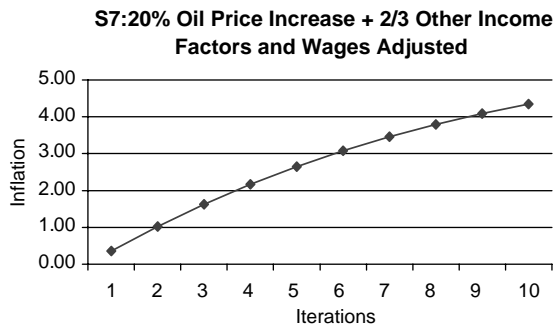


Fig. 7.

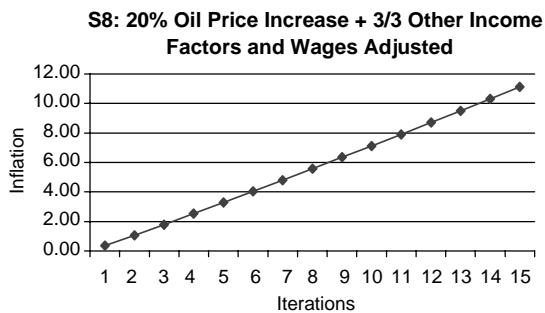


Fig. 8.

price level function is slightly convex (Fig. 8). After 15 iterations, prices increase by 11.12%. Hence, a one-time increase in crude oil prices brings persistent but decreasing price increases under S6 and S7, while in S8 it brings price increases at an increasing rate—hyperinflation.

#### 4. Conclusion

Kibritçiöğlü and Kibritçiöğlü [9] analyzes the effect of oil price shocks on the general price level. It was found that a 20% increase in crude oil price has an insignificant effect on the general price level. The general price level increases 1.08% in terms of the 1990 input–output table for Turkey. The basic assumption of the above study is that relative changes in crude oil prices do not affect the nominal wages and other income factors. However, nominal wages, profits, interest and rent contracts could be set parallel to the general price level rather than price indices excluding crude oil. In this study, in order to construct a complete picture, the effects of general price level increase on wages and other income factors such as profits, interest and rents are considered. This article suggests that to what extent crude oil prices affect the general prices depends on wages and other income factors responses to the general price level. Eight different scenarios are analyzed by using the 1990 input–output table for Turkey. This paper shows that how much general price level increases for a given increase in oil prices depends on the behavior of the wages, profits, interest and rents.

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#### References

- [1] G. Koopmann, *Oil and the International Economy: Lessons From Two Price Shocks*, Transaction Publishers, New Brunswick, NJ, 1989.
- [2] O. Aydoğuş, Cost–price relationship, price settings in sectors and inflation in Turkish economy, Third Izmir Economic Conference, Vol. 3, 4–7 June 1992, Ankara, SPO, 1993 (In Turkish).
- [3] F. Goto, *Input Output Tables in Japan and Construction of International Input Output Tables, (Compilation of Input Output Data)*, Orac-Verlag, Vienna, 1989.
- [4] L. Hoffmann, L. Jarass, The impact of rising oil prices on oil importing developing countries and the scope for adjustment, *Weltwirtschaftliches Arch.* 119 (2) (1983) 297–316.
- [5] H. Olgun, *Current Account, Money and Inflation in Turkey, 1963–1976*, METU Press, Ankara, Turkey, 1982.
- [6] R.J. Cebula, M. Fewer, Oil imports and inflation: an empirical international analysis of the imported inflation thesis *Kyklos* 33 (4) (1980) 615–622.
- [7] D. Salvatore, Oil import costs and domestic inflation in industrial countries, *Weltwirtschaftliches Arch.* 122 (2) (1986) 281–291.
- [8] R. Boyd, N.D. Uri, An evaluation of the economic effects of higher energy prices in Mexico, *Energy Policy* 25 (2) (1997) 154–165.
- [9] A. Kibritçiöğlü, B. Kibritçiöğlü, Inflation effect of crude oil prices, General Directorate of Research, Department of the Treasury, 1999 (In Turkish).
- [10] R. Miller, *Input–Output Analysis: Foundation and Extensions*, Prentice-Hall, Englewood Cliff, NJ, 1985.
- [11] H. Berument, K. Malatyali, Relationship between monetary and real aggregates: a study on Turkey, State Statistical Institute Conference, 1997, Ankara, SPO, 1997 (In Turkish).
- [12] H. Berument, *Measuring Monetary Policy for a Small Open Economy*, Mimeo, 2001.
- [13] M. Bruno, J. Sachs, *Economics of Worldwide Stagflation*, Harvard University Press, Cambridge, MA, 1985.
- [14] W. Leontief, *Input Output Economics*, Oxford University Press, New York, 1986.