Interpretation Of Oil Price Shocks On Macroeconomic Aggregates Of South Africa: Evidence From SVAR

Bünyamin Fuat Yıldız[1] ,Siamand Hesami[2] , Husam Rjoub[3] ,Wing-Keung Wong[4]

[1]*Department of Banking and Finance, Faculty of Business and Economics
Eastern Mediterranean University, Famagusta, North Cyprus, via Mersin 10, Turkey*
[2]*Department of Banking and Finance, Faculty of Business and Economics
Eastern Mediterranean University, Famagusta, North Cyprus, via Mersin 10, Turkey*
[3]*Department of Accounting and Finance, Faculty of Economics and Administrative
Sciences, Cyprus International University, Haspolat, Mersin 10, Turkey*
[4]*Department of Finance, Fintech Center, and Big Data Research Center Asia University,
Taiwan, 41354;
Department of Medical Research, China Medical University Hospital, Taiwan, 40402
Department of Economics and Finance, The Hang Seng University of Hong Kong, Hong
Kong, 999077*

*E-mail: [1]bunyaminfuatyildiz@yahoo.com, E-mail: [2]siamand.hesami@emu.edu.tr, E-mail:
[3]hrjoub@ciu.edu.tr, [4]wong@asia.edu.tw*

Abstract: The effect of oil prices on macroeconomic aggregates has always been interesting. The recent decline in oil prices has highlighted the effects of oil price shocks both in supply and demand perspective. This study investigates the impact of the oil price shocks on the South African economy using a structural Vector Autoregressive (VAR) model offered by Peersman (2005). The model was established following the economic theory, considering the short and long-term constraints—and widely cited but rarely applied in the literature.This study shows no significant effect from supply and demand shocks to the oil prices in the short-run. Furthermore, monetary policy shocks have no immediate effect on output, and demand shock has no persistent impact on GDP. An interesting result is that oil price shocks have a limited positive effect on output. The reason for this is the high density of alternative carbon-based energy sources unique to South Africa. Finally, the monetary policy shock has an impact on all variables except for output. This study's results highlight the importance of understanding the oil price movements' source since oil price shocks necessarily do not imply a positive effect on the economy. Another result of the study emphasizes the importance of inflation stabilization and the importance of managing economies' supply-side.

1. INTRODUCTION AND LITERATURE REVIEW:

The recent slump in crude oil prices has not been limited to the global economy alone but has also been observed in emerging economies. As a small open economy with limited influence on the global economy, South Africa is a net importer of crude oil. Therefore, any type of oilprice shocks, emphasized in Kilian's (2009) study, is likely to impact the South African economy. Several studies inspect the association between changes in oil prices and South Africa's macroeconomic responses (among others:Balcilar, Van Eyden, Uwilingiye, and Gupta, 2017; Chisadza, Dlamini, Gupta, and Modise, 2016; Chitiga, Fofana, and Mabugu, 2012;Fowowe, 2016; Bildirici and Bakirtas, 2014; Turhan, Hacihasanoglu, and Soytas, 2013; Ziramba, 2010), in which the literature comes up with dissimilar and even contradicting results.

For instance, Fofana, Chitiga, and Mabugu (2009) state that, given its dependence on imported oil, climbing oil prices negatively affects the South African economy. Hollander (2012) also finds that an oil price shock has a minor effect on the South African economy. Chisadza, Dlamini, Gupta, and Modise (2016), using a sign restriction-based structural vector autoregressive (SVAR) model, claim that the output is positively affected by both oil demand and oil-specific demand shocks. In contrast, oil supply shock shows no significant effect on output. Nazlioglu, Gormus, and Soytas (2019) utilize Toda–Yamamoto causality and show that despite the robust transmission mechanism from oil prices to consumer prices, the causal relationships to exchange rates and the interest rate are deferent. This result can indicate the mediating role of consumer price as the oil prices affect the monetary policy. Hollander, Gupta, and Wohar (2019) show that oil price shocks have a robust and persistent impact on domestic production and consumption activities. Therefore, they are a major determining factor of output, inflation, and interest rates. From the above-mentioned studies, one can say that the evidence is mixed as far as the effect of oil price on the South African macroeconomic variables is concerned.The contribution of this study to the literature is twofold. First, this study examines the propagation mechanism of four fundamental types of shocks – oil price shock, demand shock, supply shocks, and monetary policy shock by implying parametric constraints regarding conventional theoretical knowledge(Peersman,2005). Second, the methods applied in the aforementioned studies differ from the methodology used in this study. We essentially are interested in answering these questions: How do South Africa's main macroeconomic aggregates affected by various types of fundamental shocks, including oil price shocks? The next question is: How effective are the oil price shocks propagating essential variables for the economy and their responses?

In this paper, we follow a Structural Vector Autoregressive (SVAR) model proposed by Peersman (2005) that helps analyze the dynamic relationship between oil prices and the South African economy over time andidentify whether a variable has a persistent effect. Identifying the shocks is based on theoretical knowledge, including short-run and long-run restrictions that trace how the economy reacts plausibly by impulse response analysis. The SVAR approach tends to impose just enough restrictions to permit a coherent interpretation of the shocks to the system (Pfaff, 2008), thus enabling researchers to monitor the fundamental variables' behavior following the structural shocks. Moreover, this method provides variance decomposition to apprehend the strength of structural shocks to determine the main macroeconomic indicators of the South African economy.

2. DATA AND METHODOLOGY

West Texas Intermediate (WTI) crude oil prices are obtained from the Energy Information Administration (EIA) of the US Department of Energy. The rest of the series are collected from the Organization for Economic Co-operation and Development (OECD, 2019) web site. Data consist of quarterly series between 1990:Q1 to 2019:Q2; in logarithmic form. 31-90 days average interbank lending ratesare derived to represent short-run interest rates. Finally, CPI for inflation and real GDP series are fixed as 2015 = 100.

Structural Vector Autoregressions(SVAR) based on vector autoregressionsallow us to apply restrictions based on theoretical knowledge. Since the studies based on SVARs are identification driven (Kilian, 2011), it allows us to get plausible patterns of the impulse responses for policy implications and Forecast Error Variance Decomposition (FEVD) for examining the roots of fluctuations for the subjected variables (KilianandLütkepohl, 2017).To understand structural VAR, a simple VARs matrix below:

$$z_t = A_k Y_{t-k} + e_t \qquad (1)$$

in which A_k indicates square matrices, and $e_t$is reduced form innovations with zero mean and lead to the following SVAR equation

$$Bz_t = B_k z_{t-k} + \epsilon_t \qquad (2)$$

where ϵ_t denotesindependent and uncorrelated innovations. The aim is to take structural innovations by $Be_t = \epsilon_t$. The structural innovations, demonstratedby ϵ_t, are linear combinations of VAR errors. Eventually, the structural model is designable in MA form, which allows calculating impulse response functions.

$$z_t = D_0 e_t + D_1 e_{t-1} + \cdots + D_k e_{t-k} \qquad (3)$$

where D_k indicateK^{th} lag coefficient of impulse responses of z_{t+k} representing unit standard deviation changee_t. Thus, the MA representation of SVAR is attained as:

$$z_t = C_0 \epsilon_t + C_1 \epsilon_{t-1} + \cdots + D_k z_{t-k} \epsilon_t \qquad (4)$$

where the Kth forecast horizon structuralinnovations ofz_{t-k} determined by $C_k = D_k B_0^{-1}$.
The model includes two supply-side shocks (ϵ_{1t}) and (ϵ_{2t}) —that respectively represent oil price shocks and supply shocks to infer supply-side effects in the economy. The rest of the innovations in our model represent demand (ϵ_{3t}) and monetary policy(ϵ_{4t}) shocks.Both short-term and long-term constraints have been established when constructing our model. A particular arrangement of short-run restrictions on subjected shocks is implemented as a)Apart from oil price shocks, there is no simultaneous impact of the non-oil shock on oil prices.To express this in another way, the effect of changes in oil prices on other variables are exogenous—that is, in real GDP, price levels, and interest rate equations. b) Monetary policy shocks do not have a simultaneous impact on real GDP.Turning now to our model's long-term constraints, we construct monetary policy shocks have a long-term effect on variables other than output. Secondly, the long-term effects of the demand shock on real GDP negligible.You may access a comprehensive demonstration of our model and software codes on Ouliaris et al. (2016), which is beyond the scope of this paper.

Empirical Results

1.1. Impulse Response

To impact of demand and monetary policy shocks presented in Figure 1. Figure 1 shows that the one standard deviation demand shock leads to a decrease in the oil price, which peaked in the 5th quarter. Gupta and Modise (2013) state that increasing economic activity might arise, which corresponds to increasing demand for manufactured products, leading to positive global petroleum production changes due to the boom in business cycles. The response of demand shock leads to rises in output, which is consistent with the extant literature. The observed effect of a demand shock on inflation and interest rates is significant. Furthermore, the demand shock has emerged and creates an equally permanent outlook on inflation. This propagation mechanism justifies us the new classics and monetarists who find Keynesian demand management policies out of place.

Moreover, the monetary policy shock has a negative effect on oil prices while impacts the interest rates positively. In contrast, monetary policy shock has no significant effect on the levels of output and inflation.
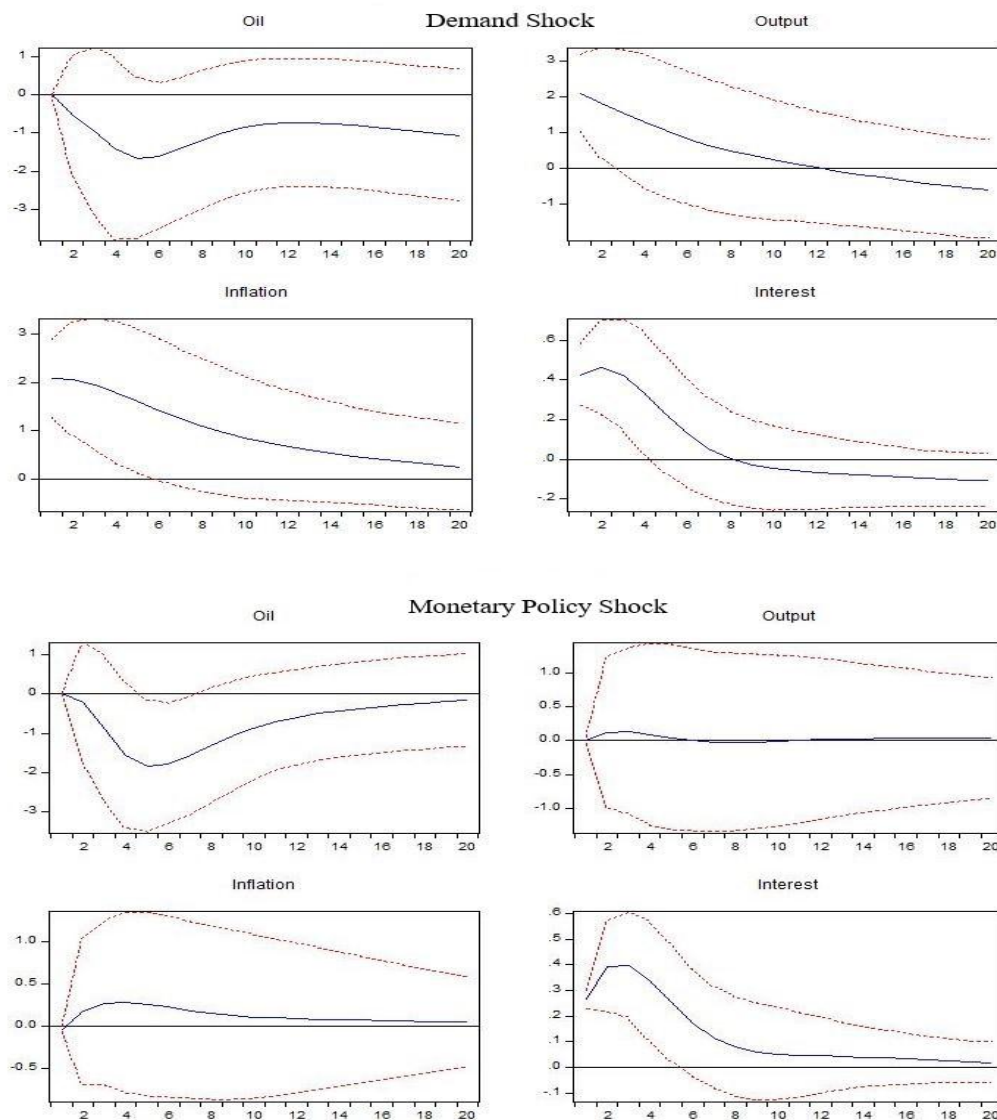

Figure 1. The Impact of Demand and Monetary Policy Shock

The impulse response functions of supply and oil price shocks are illustrated in Figure 2. Our findings indicatethat the reaction of oil prices to supply shocks is persistently negative. This may indicate that firms operating on a long-term contract basis have negative and permanent reactions to supply-side changes. However, the reaction of inflation, interest rates, and output to the supply shocksare positive. Considering the impact of oil price shocks on the South African macroeconomy, oil price shock leads to an increase in output. In times of oil price shocks, South African industries considerably benefit from regional coal reserves, which comprise approximately 70% of the total energy production (Chiweza and Aye, 2018). In other words, adverse oil price shocks would create a competitive advantage in South Africa. Oil price shocks' effect turned out to be positive as expected for the rest of the three variables.
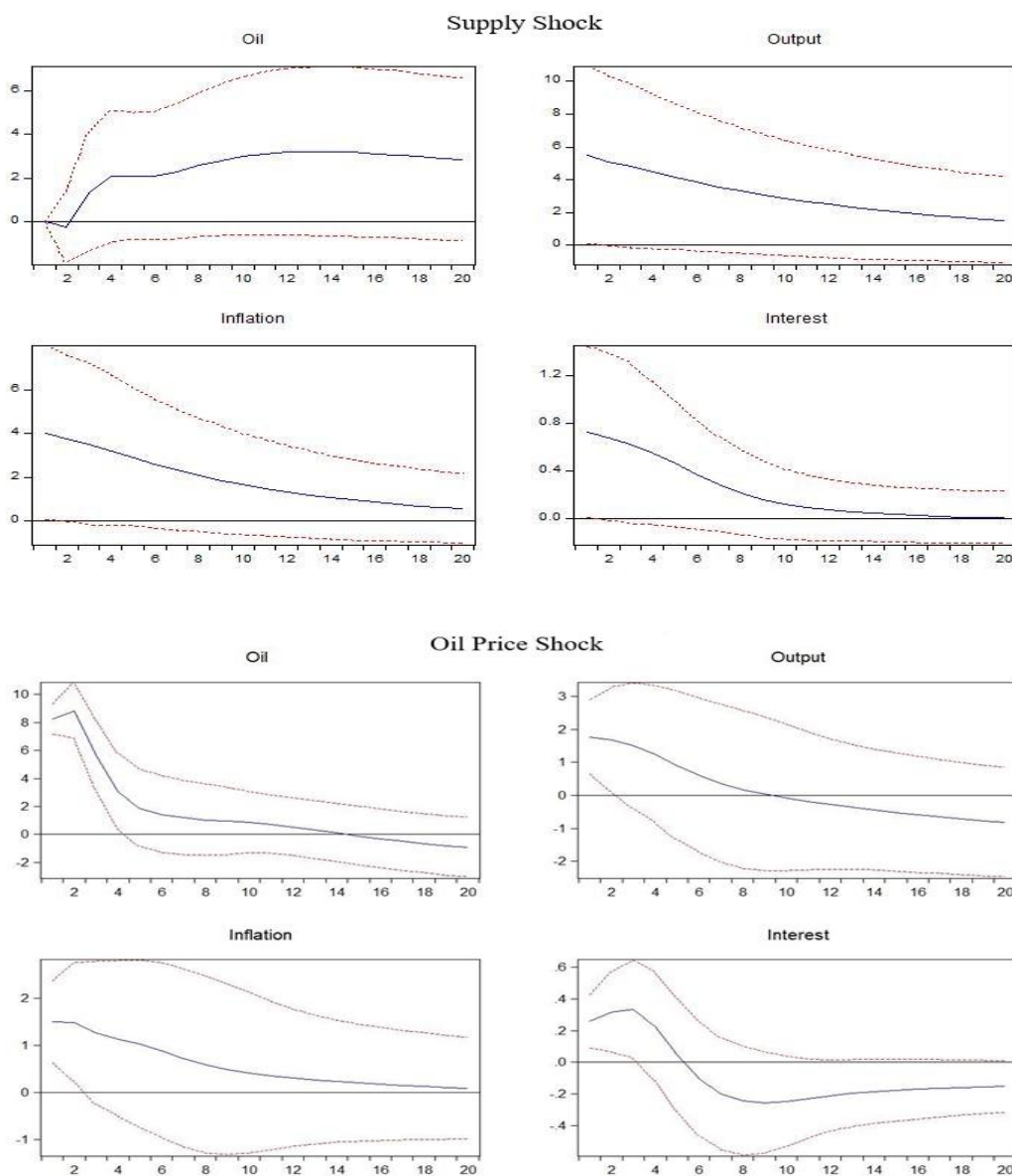

Figure 2. The impact of Supply and Oil Price Shock

1.2.FEVD

This section will try to understand which shocks induced fluctuations in the variables that make up our model by variance decomposition. Table 1 provides the FEVD result for different time horizons. There is a prevalence of oil price shocks in the fourth quarter while considering the changes in oil prices, around 93 percent. Although this strong effect persists in the long run, the initially weak supply shocks increase the impact of the oil price fluctuation to around 32 percent in the long run.Estimating the source of the fluctuations in GDP for South Africa reveals the high dominance of supply shocks. Moreover, the limited effect of the oil price and monetary policy shocks is observed to be the source of inflation fluctuations. Examining the factors creating the inflationary effect for South Africa inthe long-run, the results show that 20 percent of the fluctuation is due to demand shock, and supply shocks drive 71 percent. Eventually, when the source of the fluctuations in interest rates is examined, supply shocks have a significant role in the long term, 49 percent. The rest of the shocks equally influenced interest rates in the long-run.

Table 1: Variance Decomposition of SVAR model					
Variable/Shock	ime	OP	Demand	Supply	MP
		93	2	3	2
ΔOil		78	5	11	6
	2	67	5	22	6
	6	58	5	32	5
		8	9	82	1
ΔGDP		6	7	86	1
	2	5	6	87	2
	6	5	6	88	1
		9	20	69	2
ΔInflation		9	20	70	1
	2	8	20	71	1
	6	8	20	71	1
		10	22	52	16
Interest		11	19	54	16
		15	18	52	15

	2				
	6	18	18	49	15

3. CONCLUSION

This study aims to observe the propagation mechanism of oil price shocks on the South African main macroeconomic aggregates. In this respect, we have applied the structural VAR model of Peersman (2005) to assess the effects of oil price shocks on the South African macroeconomy.

What makes the study interesting for policymakers is that our model is theoretically designed by following economic doctrines through imposing theoretical knowledge restrictions (Peersman, 2005). Since our model includes intertemporal constraints, we aim to acquire more practical results than traditional VAR models. VAR-based economic models are not as effective as SVARs in reflecting economic units' behavior and gathering credible impulse responses (Kilian and Lütkepohl, 2017). In this context, the fundamentals of the model are based on the works of Gali (1992) and Gerlach and Smets (1995), as explained in detail by Ouliaris, Pagan, and Restrepo (2016). The present paper studies four fundamental shocks: supply-side oil price shocks, supply shocks, monetary policy shocks, and demand shocks.

As we can see from the variance decomposition and impulse-response functions, firstly, supply-side shocks have a significant negative impact on oil prices. Secondly, demand-side shocks created inflation, and its success in generating real growth is doubtful. Finally, the oil price shocks, which we consider unique to South Africa, create positive output in the South African economy, albeit limited.

The probable reason for this is that South Africa creates a comparative advantage due to its richness in alternative fossil fuels. Another important result in our study is todetermine that the supply-side shocks dominate inflation at a rate of approximately seventy percent. The interest rate fluctuations are also majorly governed by the supply-side.

These results reflect that political targets based on the inflation targeting regime should be in the first place. With the decrease in inflation, the built trust will boost production and employment indirectly. It will also encourage investments by lowering real interest rates in the long term. Resulting in a more stable exchange rate and stabilize the balance of payments deficit.

Contrary to studies that neglect the importance of supply-side conditions, this study highlights the importance of supply economics. Economies should examine the production structure of the economy rather than household consumption.

The present study foresee that tax adjustments will create lasting positive effects, although with a delay, on the economy's productive capacity. the change created in relative prices leads to changes in the orientation of the sources of demand and their areas of alternative use. Future researchers can evaluate the impact of tax rates as a political tool in the model. Moreover, it would be important to examine the effects of tax rates on productive components of economies.

4. REFERENCES

[1] Aye, G. C., Dadam, V., Gupta, R., & Mamba, B. (2014).Oil price uncertainty and manufacturing production. *Energy Economics*, *43*, 41-47.

[2] Balcilar, M., Van Eyden, R., Uwilingiye, J., & Gupta, R. (2017). The Impact of Oil Price on South African GDP Growth: A Bayesian Markov Switching-VAR Analysis. *African Development Review*, *29*(2), 319-336.

[3] Bildirici, M. E., &Bakirtas, T. (2014).The relationship among oil, natural gas, coal consumption, and economic growth in BRICS (Brazil, Russian, India, China, Turkey, and South Africa) countries.*Energy*, *65*, 134-144.

[4] Chisadza, C., Dlamini, J., Gupta, R., &Modise, M. P. (2016). The impact of oil shocks on the South African economy. *Energy Sources, Part B: Economics, Planning, and Policy*, *11*(8), 739-745.

[5] Chitiga, M., Fofana, I., &Mabugu, R. (2012).The poverty implications of high oil prices in South Africa. *Environment and Development Economics*, *17*(3), 293-313.

[6] Chiweza, J. T., & Aye, G. C. (2018). The effects of oil price uncertainty on economic activities in South Africa. *Cogent Economics & Finance*, *6*(1), 1518117.

[7] Fofana, I., Chitiga, M., &Mabugu, R. (2009). Oil prices and the South African economy: A macro–meso–micro analysis. *Energy policy*, *37*(12), 5509-5518.

[8] Fowowe, B. (2016). Do oil prices drive agricultural commodity prices? Evidence from South Africa. *Energy*, *104*, 149-157.

[9] Gali, J. (1992). How well does the IS-LM model fit postwar US data?.*The Quarterly Journal of Economics*, *107*(2), 709-738.

[10] Gerlach, S., &Smets, F. (1995).Contagious speculative attacks.*European Journal of Political Economy*, *11*(1), 45-63.

[11] Gupta, R., &Kotze, K. (2017). The role of oil prices in the forecasts of South African interest rates: A Bayesian approach. *Energy Economics*, *61*, 270-278.

[12] Gupta, R., &Modise, M. P. (2013). Does the source of oil price shocks matter for South African stock returns? A structural VAR approach.*Energy Economics*, *40*, 825-831.

[13] Hollander, H., Gupta, R., &Wohar, M. E. (2019). The impact of oil shocks in a small open economy New-Keynesian dynamic stochastic general equilibrium model for an oil-importing country: The case of South Africa. *Emerging Markets Finance and Trade*, *55*(7), 1593-1618.

[14] Kilian, L. (2011). Structural Vector Autoregressions (No. 8515).CEPR Discussion Papers.

[15] Kilian, L., &Lütkepohl, H. (2017).Structural vector autoregressive analysis.Cambridge University Press.

[16] OECD (2019)."Main Economic Indicators - complete database", Main Economic Indicators (database), https://doi.org/10.1787/data-00052-en (accessed on 14 December 2019).

[17] Ouliaris, S., Pagan, A., &Restrepo, J. (2016). Quantitative Macroeconomic Modeling with Structural Vector Autoregressions–An EViews Implementation. *Washington DC: IMF Institute for Capacity Development*.

[18] Nazlioglu, S., Gormus, A., &Soytas, U. (2019). Oil prices and monetary policy in emerging markets: structural shifts in causal linkages. *Emerging Markets Finance and Trade*, *55*(1), 105-117.

[19] Peersman, G. (2005). What caused the early millennium slowdown? Evidence based on vector autoregressions. *Journal of Applied Econometrics*, *20*(2), 185-207.

[20] Pfaff, B. (2008). VAR, SVAR and SVEC models: Implementation within R package vars. *Journal of Statistical Software*, *27*(4), 1-32.

[21] Turhan, I., Hacihasanoglu, E., &Soytas, U. (2013).Oil prices and emerging market exchange rates. *Emerging Markets Finance and Trade*, *49*(sup1), 21-36.

[22] Ziramba, E. (2010). Price and income elasticities of crude oil import demand in South Africa: A cointegration analysis. *Energy Policy*, *38*(12), 7844-7849.